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GAS JOURNAL

LIGHT • HEAT • POWER • BYE-PRODUCTS

[Founded in 1849 as the "Journal of Gas Lighting."]

VOL. CLVI. No. 3049.] LONDON, OCTOBER 19, 1921. [73RD YEAR. PRICE 2s.

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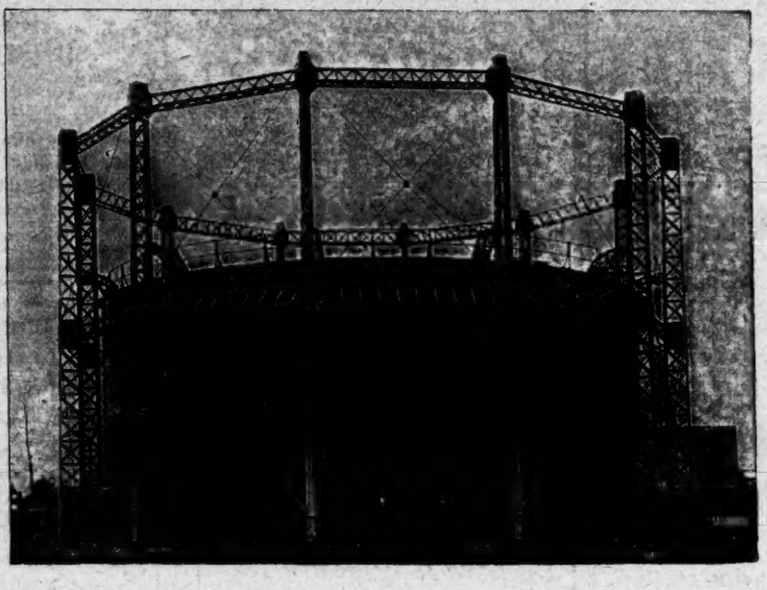

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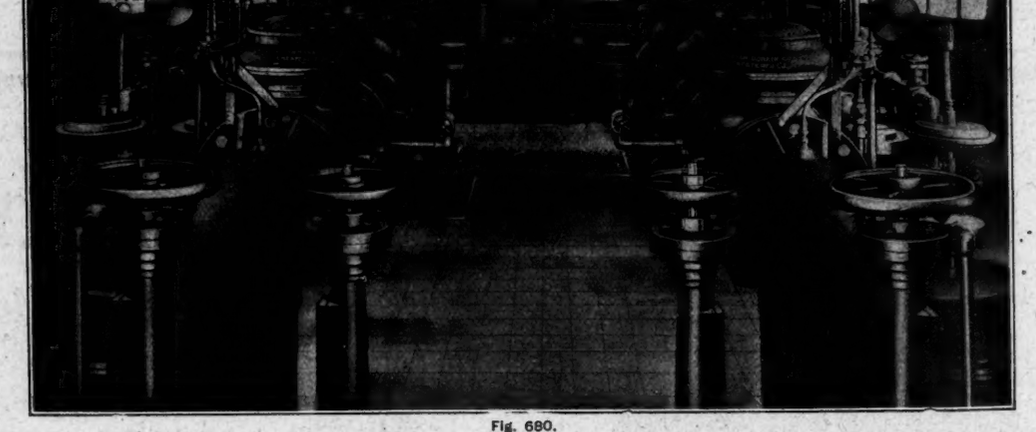

Fig. 680.

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EDITOR & PUBLISHER: WALTER KING. OFFICE: 11, BOLT COURT, FLEET ST., LONDON, E.C. 4.

VOL. CLVI., No. 3049.] WEDNESDAY, OCTOBER 19, 1921. [73RD YEAR.

EDITORIAL NOTES.

The Progress of Scientific Penetration.

THE annual meeting of the Institution of Gas Engineers has been held, and in a calmer atmosphere than would have been the case had it been, as originally fixed, at the end of May, when the country was in the midst of the biggest and most destructive strike that it has ever known. Industry is slowly recovering; but the unemployment that exists is a densely black cloud, formed by the accumulation of many causes—one being the tactless policy of the myopes among the trade union leaders. However, regarded generally, the outlook of the gas industry has greatly improved, seeing that it is emerging—may be tardily, but still emerging—from some of its difficulties, and moreover endowed with greater liberties than was the case when the members of the Institution previously met in June, 1920. Since then the industry has successfully passed through successive attacks upon it; but one, the coal strike, has been for it a costly matter. From the other attacks made with the view to impose upon it new restrictions relating to pressure, inerts, and carbon monoxide, it has issued with right and justification on its side. And there is the promise that though much time must pass before the country fully recovers its industrial and commercial stride, the gas industry will share in the enjoyment of every gain in the steps to a renewal of national prosperity. Thus it was the President of the Institution (Mr. Thomas Goulden, M.Inst.C.E.) faced one of the largest meetings of members that it has been our lot to witness, and a meeting constituted of men very optimistic as to the future.

As we reflect upon the meeting, one of the first things that strikes us is the great difference there was in its constitution, compared with the meetings of even a few short years ago. Men come, and men go. As we ruminate upon the topics that were before the members, and the character of the communications and the discussions, we see how very far science has penetrated into the industry's work, and has commanded a more elevated knowledge on the part of its professional men. The impression deepens now year by year. The growth has been gradual; but viewed from the standpoint of to-day, and making contrast with but even a decade ago, it is a remarkable change. It has been coming upon us so gradually that it has hardly been noticed. It is, however, a right and a natural development. We could not have progressed without it. New knowledge is a new power rightly applied. And new knowledge keeps flowing into the industry—enlarging its horizon, its ability, and its functions. The President's address, the reports of Committees, the papers read, the character of the discussions, the speeches made at the luncheon given at the East Greenwich works by the President (Dr. Carpenter) and the Directors of the South Metropolitan Gas Company, the works there, and the adjoining Fuel Research Board Station, one and all testify to the penetration of science into the industry's policy, processes, and applications. Its guidance is welcomed. This guidance is giving the industry greater commercial power and latitude; for the restrictions from which we have suffered have not all been of legislative making, but in large part have been due to our own deficiencies in knowledge. The men of the industry may as well confess to the truth; for there is conviction of the former existence of deficiencies in the fresh enlightenment that comes from belated scientific exploration.

Most gas engineers welcome the change; there are a few who do not. This solely from selfish motives. Its attitude suggests a fear of dethronement owing to personal incapacity to keep pace with the new teachings and their requirements. But personal interests cannot stand in the way of the larger interests which it is the duty of everyone to serve. Selfish motives or personal interests notwithstanding, progress will come, and must come. Personal interests cannot form a sufficiently strong dam to prevent it. And such a dam would meet destruction merely from the fact that every undertaking, according to its conditions, will have to live up to the new standards of policy, processes, and applications, or else the public will want to know the reason why.

As Seen in Reports and Papers.

WE look to the notable inquiry that has been made by the Gas Investigation Committee into recording calorimeters, which is a natural development from the work they did that carried so much conviction as to gas of differing calorific power having an approximate parallelism in respect of efficiency. Prof. Cobb, Mr. James W. Wood, Mr. J. F. Simmance, and others who have studied the work done, or have taken part in producing recording calorimeters, tell us that the difficulties in making one that can be used officially and for penal purposes appear to be so insuperable that they fear the task is one in which success is impossible, and that the best that can be accomplished is (it is already an actuality) to provide recording calorimeters which will help to control on the works the production of gas of the declared thermal quality. It seems to us that judgment is being made somewhat early, when we look at the point to which success has been brought by the Simmance, the Fairweather, and the Thomas recorders; and there are on offer other instruments—the Beasley, the Brady, and the "Sigma"—quite suitable for works' purposes. The fact that recently improvements which have surmounted certain troubles have been effected in the Simmance instrument is encouraging. Certainly, too, the Gas Referees are not without hope that there will be eventual success, though not at the moment satisfied. However, as the President says, the gas industry may rely on the Gas Referees not making any prescription in this direction until they are themselves confident in regard to the point of reliability. The importance of accuracy and reliability is evidenced by the realization of the approximate cost of error to either gas undertakings or consumers. At the moment, seeing the progress so far achieved scientifically in making recording calorimeters, we are quite reluctant to say that science will not discover—perhaps not immediately—the means of obtaining in a recording calorimeter fair security against the possibility of error, either by improvements or the application of new principles. There is the report upon Dr. Parker's investigations (under the supervision of the Gas Investigation Committee) into the manufacture of blue water gas. In this process the efficiency is low compared with producer gas working and complete carbonization, though perhaps not so low as Dr. Parker has calculated. But it is scientific research that is pointing to the loopholes of heat loss, and to how thermal efficiency may be raised within the process itself, quite apart from the application of the auxiliary waste-heat boiler.

The work both in regard to calorimeters and the blue water-gas process came in for a certain amount of criticism (in the former case from Mr. Simmance, and in the later case from Mr. E. G. Stewart), in respect of either method or omission, just as Prof. Cobb and Dr. Parker had a little comment to make regarding the absence of thermal balances from the paper of Sir George Beilby on the investigations

at the Fuel Research Station into steaming in vertical retorts, and Mr. Thomas Glover as to the deficiency in result in respect of sulphate of ammonia. These are more or less side-issues, but quite fair criticism, which will tend to keep investigators up to the mark in respect of the treatment of all factors. The importance of the information from the Fuel Research Station lies in the guidance it affords to the attainment of higher efficiencies—as was the case with the work of the Gas Investigation Committee into the same subject at Uddingston and Birmingham. From all this work, positive things are being learned which formerly were only matters of divergent opinion and conjecture. One is that, by steaming in vertical retorts, the consumption of fuel does not rise in proportion to the increase in the gas output. The two causes of this are that some of the heat of the incandescent coke is utilized in the manufacture of the water gas, and the sensible heat of the latter renders internal aid in the heating of the coal in the upper part of the retort. Another lesson is that the tests of both the Gas Investigation Committee and the Fuel Research Board point to the economic limit of steaming being about 20 p.ct. A further point is that which was emphasized by the new President (Mr. Thomas Hardie), that, if the heat is properly proportioned to the physical conditions of the coal, any class of coal can be carbonized in continuous vertical retorts, which is a denial of the truth of the submissions in this regard of some other engineers.

Passing on to the refractory materials research. There we see the same thing. Science has come to the industry's aid. The importance of this work is greater than it ever was. Carbonizing plant is much more costly to-day; and any improvement in refractory materials which will realize longer life and more work for a given expenditure on them is an economy—individually and in the aggregate—of no mean sum. Much more is known to-day of refractory materials than was the case when Mr. F. J. Bywater read his paper on the subject at the White City, which paper resulted in the formation of a Joint Committee by the Institution and the Society of British Gas Industries to investigate refractories, aided by the skill and knowledge of Dr. Mellor. We are sorry to hear from Mr. A. E. Broadberry, who is Chairman of the Committee which is now affiliated with the Refractories Research Association, that the importance of the work is not represented in the amount of financial support that is rendered to the Association by the manufacturers and the industries concerned. He calculates that something like a million-and-a-half sterling is spent annually in renewals of and repairs to retort-settings and retorts, and yet the contribution to research to the end of improvement and economy is of a relatively paltry order. This should not be. Some change in this respect must be made; for if the work is allowed to be discontinued through inadequate support, both users and manufacturers of the materials and goods will be cumulatively heavy losers.

There is no question that there has been a progressive improvement in retort material. We see this from the paper by Mr. G. M. Gill, on "Carbonization in Horizontal "Retorts," where he showed an increasing ton and working-day life for the retorts of the South Metropolitan Gas Company. This point, however, was only incidental to the paper, which was constituted of an unvarnished, but highly interesting, statement as to how the Company have tuned-up every detail of the horizontal retort process with the view of securing the highest efficiency in working and product result. There are competent gas men who consider the Company's supervision is overdone, and that the standards applying to production are in themselves a limitation to the cheapening of the cost of therms to the consumer. But all that Mr. Gill does in the paper is to say in effect: "These are our present practices, which represent the exist-"ing fixed policy of the Company. You are not asked to "adopt them; but you may like to know what we do. We "leave this policy and our results to your judgment, to say "whether we are right or wrong." There is one thing with which everybody must agree, and it is that no one can but admire the consistency with which the Company carry out their fixed policy of high standards of efficiency in all departments of their work. The results are there. But Dr. Carpenter some time since, and Mr. Gill now, accentuate this: The policy of to-day must not be construed to mean that the Company are, for example, irrevocably wedded to 550 B.Th.U. gas. They believe it is the best quality in their existing works, district, and utilization circumstances for them as an all-coal-gas Company. But they are quite prepared, when satisfied that the interests of the Company and their consumers demand it, to shift from this figure to the one that presents the most economic advantage. Even then the policy of high standards of efficiency, as established by the Company's own chemical and physical research department, would be adhered to. It must not be forgotten (reminder was given of this by Mr. H. E. Jones at the luncheon at East Greenwich) that it was the President of the Company who brought into the service of the gas industry the Carpenter burner, which was the "bridge" over which fair values were accorded to the primary product of the industry. Its influence upon present calorific power declarations is evident.

Still further advance has been made possible largely by scientific investigation. This is seen in the paper by the Society of British Gas Industries, which was presented by Mr. Fred. J. West. This shows how plants have been improved, simplified, and rendered more efficient for the distillation of tar and the manufacture of sulphate of ammonia, which enable tar to be distilled by more gas undertakings with enhanced profit, and sulphate of ammonia to be prepared for the market in a condition which will allow it, by neutralization and drying, to compete better with the expansion in the production and supply of fertilizers of high quality from other sources than coal. The market demands are what have to be met, and not the mere gratification of the likes or dislikes of those producers who think that what has been is good enough in these progressive times. One way of improving the industry's commercial position is by increasing the amount of ammonia by bringing into account a larger percentage of the original nitrogen in the coal. Doing this would reduce costs, and therefore the price at which sulphate of ammonia can be sold. Thus the researches that Prof. Cobb and Dr. Monkhouse are making into the liberation of nitrogen from coal and coke as ammonia (the initial work in connection with which supplied the material for another paper) will be followed with considerable interest. The effect of atmosphere on the liberation of nitrogen as ammonia is a fascinating study; and the results obtained so far from experimental work with atmospheres of nitrogen, hydrogen, and steam will be widely examined.

The remarkable increase of the avenues for exploration by the Life of Gas-Meters Research Committee—whose work has revealed the afflictions that modern gas making imposes upon gas-meters and the canalization, through the presence of corrosive substances in the gas and the insuffi cient presence of palliative or neutralizing constituents—is other evidence of the assistance that scientific work i giving in showing the way to the retention of the economies of modern gas-making processes by applying correctives to the noxious constituents of the gas. Related to this subject is the paper by the Research Chemist to the Committee (Mr. J. G. Taplay) on the subject of the external corrosion of mains through both acid and alkaline earths—the illustrations being drawn from experiences in the area of the Gas Light and Coke Company, at the Bow Common station of which Company, by the way, Mr. Taplay is pursuing his investigations into the use of chalk for capturing that "vicious" compound, hydrocyanic acid. This refers, of course, to internal troubles; but as to the external ones, the moral of Mr. Taplay's paper is that engineers should know something chemically as to the nature of the subsoil in which they lay pipes, so as to afford to them the necessary amount of protection. Pipes are often laid in soils that are inimical to metal; and the engineer knows nothing about it until more or less serious mischief is done.

There was very little said at the meeting about the applications of gas. This is a matter that now comes largely under the care and surveillance of the British Commercial Gas Association. But in several respects Mr. Robert Watson's report, as the Delegate of the Institution to the International Commission on Illumination, will be found particularly interesting and instructive, especially to those who require information as to the proper degree of illumination to afford in factories for general purposes. This is no doubt the side of the report that will be regarded as containing the most practical usefulness.

Wherever we look in the reports and the papers presented at the meeting, we find illustration of the rapidity of the penetration which scientific research is making into the industry's practices, to the advantage of the industry and its customers. Rule-of-thumb and traditional notions are being evicted; and reason and rule provided by scientific work will take the industry to new heights and over wider spaces

in the service of the public. This has all come to us none too early; but now that it has come, and is vigorous in growth and result, every advantage must be taken of it.

Extra Low Calorific Values.

In season and out of season, Mr. George Helps preaches the gospel of low calorific value gas. Somewhat out of season, he introduced the matter twice at the meeting of the Institution. We do not mean by this that the present is not an opportune time to discuss the question, and to keep it prominent. But the fact remains that he introduced it during the discussion on Sir George Beilby's contribution to the proceedings, and again during that on Mr. G. M. Gill's paper, neither of which was dealing with the economics of respectively high and low thermal concentrations in gas. Mr. Helps regretted that Sir George's paper did not show something as to the commercial value of the results. On Mr. Gill's paper, he stated that if the South Metropolitan Company would dilute their gas down to 250 B.Th.U. (as he is doing at Nuneaton), it would work-out to something like 45,000 c.ft. per ton, and they could give the consumers three times the "gas" for the same money. Probably they could, if they were in the position to send the necessary quantity of gas through to the points of consumption over their densely populated area. But Mr. Helps, it will be noted, speaks of "gas," and not of thermal value; and as his 45,000 c.ft. of 250 B.Th.U. gas gives a multiple of 11,250,000 B.Th.U., this shows conclusively that the South Metropolitan Company could not possibly, even if there were no physical disabilities, supply to the consumer, with that gas, three times the thermal value of their gas for the same amount of money.

Again, while Mr. Helps complains that Sir George did not show the commercial value of the work in his paper, Mr. Helps himself has not yet demonstrated at Nuneaton what he can do commercially in relation to his consumers and his Company. As we gather from his remarks on Mr. Gill's paper, he is at present charging 3s. 5d. per 1000 c.ft. of 250 B.Th.U. gas; but in a month or two, he is going to show what Nuneaton really can do. This is what the gas industry wants, is waiting for, and will look forward to with pleasure. Something more than postulation is needed. And if Mr. Helps wins through, with satisfaction to his consumers, financial gain to his Company, and credit to himself, no one will be more sincere in congratulation than we shall be. Even though Nuneaton, which, judging from the statements of the protagonist, is apparently in a condition for the change—being now supplied with 250 B.Th.U. gas—discloses a wonderful success in its local circumstances, it will not prove that the same principles and practices would apply to many other places, owing to the disabilities imposed by distribution systems, meters, and internal piping. No one is saying that Mr. Helps is wrong regarding 250 B.Th.U. gas. What men are saying is that, established as gas-works systems are, we must proceed in the lowering of calorific values by the route of evolution as conditions will allow, and not by revolution which will mean chaos. Evolution has been the way of things now for some years. When 16-candle gas was supplied, tested by the "Metropolitan" No. 1 burner, the calorific value was something like 620 B.Th.U. per cubic foot. The values that are generally being "declared" to-day are between 450 and 475 B.Th.U. This is a very strong indication of the views of gas engineers as formed under their existing local conditions. What, however, they are declaring now does not by any means tie them to this value for all time; the Gas Regulation Act provides for descent if economically sound.

Now, gas engineers not being so quickly responsive as Mr. Helps would like them to be to his preaching of the gospel of extra-low-grade gas, he announces his intention of indulging in a piece of missionary enterprise among the gas consumers of the country, who, in his opinion, will not only demand, but will have, the gas that he advocates. Will the consumers accompany their demand and insistence with a guarantee for the redemption of the cost of all the plant that will have to be scrapped, and for the provision of any capital expenditure in excess that will have to be incurred? We would earnestly suggest to Mr. Helps that he should go about this missionary enterprise in a piecemeal fashion; inasmuch as, if those to whom the fortunes and obligations of gas undertakings are entrusted, unanimously agree to cut-down the thermal concentration of their gas by about one-half, it is plain that the manufacturers of the plant may become snowed-under with orders. Whatever the future may prove in regard to calorific values, change from things established cannot be rushed, but must come about systematically and in conformity with the capacity of every element in the system for dealing with the new conditions.

Trained Men for the Business End.

As has been remarked in an earlier article, there is a feature about the South Metropolitan Gas Company with which no one can quarrel and all can admire. It is that they have a fixed policy; and what is more, they live-up to it in every department from beginning to end. This policy is summed-up by the words "high efficiency." Every undertaking of less magnitude cannot aspire to accomplish all the Company do to maintain this efficiency throughout; but every undertaking can aspire to the highest attainable efficiency, from the alpha to the omega of their operations, within the limits of their circumstances. The members of the Institution of Gas Engineers learned a good deal about this policy of the South Metropolitan Company last week, both in the paper by the Chief Engineer (Mr. G. M. Gill) and during their inspection of the East Greenwich works, and their hospitable reception by the President of the Company (Dr. Carpenter) and his colleagues. After luncheon on the occasion, there were speeches; and one of the speakers was Mr. H. E. Jones. He pointed to what is an obvious, though often missed fact, that consistency of gas product is one of the best possible contributors to the comfort of the men on the district who have business relations with the consumers. This those men get in the South Metropolitan area; and now the Company are extending their propaganda work by a film (part of which was shown to the members who were able to stay to see it), and which will have educative value in showing the people of South London the work that proceeds in making gas, the extent and multiplicity of processes associated with it, and the applications of gas—presented in a manner which will interest all, and particularly those (this in the applications of gas to domestic purposes) who are about to start housekeeping.

This brings us to what we regard as the principal point in the speech made by Dr. Carpenter after the luncheon. It is one that appeals to us strongly, because we have come across gas undertakings the weakest part of the systems of which is in the district with the consumers, although that is the very part where the highest attainable efficiency means stability for the whole concern. At this vital part of the system, there should be trained men, technically and commercially qualified in all matters appertaining to the utilization of gas. Looking through the gas industry, Dr. Carpenter has obviously seen in places the weakness in this vital quarter; for, seriously and earnestly, he urged consideration of the matter, and not only consideration, but action. Put briefly, what he said was that gas undertakings must be as efficient in their fighting organization as they are in their organization for the production of gas. This will involve the training and bringing-up of another class of person for the work of the industry. He asserts that it is easier to find suitable men to manage gas-works than it is to find suitable men to manage the district work of an undertaking. There is a great deal of truth in this; for as a matter of fact, training has been confined for the most part to gas engineers, and little attention has been paid to the training of the men who sell the gas and who have dealings with the consumer. To a large extent, unless they themselves have been industrious in the study of the details of their work, they have been left to pick-up haphazard what they know. Dr. Carpenter urges that this should not continue. The gas industry has about it now more strenuous competition; and this will grow as conditions ease. The industry has larger opportunities now than ever before through the more open field provided by the Gas Regulation Act. Every undertaking of any standing therefore needs thoroughly trained and capable men—men who know their job from beginning to end—to conduct their business with the consumers, in order to uphold gas in competition, and to extend its service. Gas undertakings are traders; and it is only through trade that they can develop. There then the best men are needed. To get such men, facilities must be provided for their training.

Wages Sliding-Scale for the Gas Industry.

Under this heading, or something akin to it, paragraphs have been published in the Provincial Press giving a scheme which is

under consideration for the application of a wages sliding-scale to the gas industry. This publication is entirely premature. We know that negotiations have been going on, and in the most amicable spirit between all parties concerned. The final meeting connected with the matter, however, has not yet been held. So that whatever has so far been drafted can only be taken as more or less provisional, until there is final acceptance.

Daily Press Journalists and Gas Supply.

We commend to the consideration of the Executive of the British Commercial Gas Association an educational campaign among public newspaper journalists. Lately we have come up against some who have given striking evidence of an amount of ignorance concerning gas matters which is appalling; and occasionally the ignorance finds place in their writings intended for the edification of, but actually disseminating false information among, the general public. Attention has been called to an editorial paragraph in the "Nottingham Guardian" which illustrates the point. It is complained that at Nottingham the gas will not give any useful illumination without a gas-mantle; and this is said to be expensive. No one with common sense would say this. No one would use gas without an incandescent mantle who had his wits about him; for the value given in light by it for a small part of the gas consumed by a flat-flame is such that the saving of gas soon pays for the incandescent burner. Then it is complained by this "leader" of public opinion that the gas supplied is not "real gas." "It is said to be made largely with water, and to be mainly hydrogen." This is really funny; but we will not waste the time of our technical readers and our own time and space in replying to such nonsense. The journalist who is responsible for this should seek out Mr. J. Wilkinson at the gas-works, and get a little enlightenment on the works regarding the manufacture of gas, and in the laboratories some information as to its constitution there, as well as figures regarding relative consumption and light-giving capacity as between incandescent and flat-flame burners. Also some particulars as to the extent that gas is required for heating purposes to-day; the same gas being of the character suited for incandescent burners. Progress in satisfying the gas requirements of extending applications cannot be retarded for the sake of those who still desire to utilize the primitive flat flame.

Only a Happy Memory.

During September only 31,032 tons of gas coke were exported; the total value being £51,563, or an average of about £1 13s. 2d. per ton. In September, 1920, 74,133 tons were shipped; the value being £609,800, or an average of about £8 4s. 6d. per ton. That is a difference of £6 11s. 4d. per ton, and represents a condition of things that for some gas undertakings is only a happy memory. For the nine months 270,945 tons of gas coke have left these shores, with a value of £644,363. In the same period of 1920, 632,226 tons were shipped, of a value of £3,859,934. In other words, very nearly 3¼ millions sterling more were received for gas coke in the corresponding period last year.

Coal Strike and Coal Imports.

Although the imports of coal have fallen away substantially during the past month, the total (we learn from the "Iron and Coal Trades Review") is still comparatively heavy. During last month 20,914 tons, valued at £59,662, were brought in; the average value being £2 17s. 0¼d. per ton. For the nine months of the year, the imports have aggregated 3,426,845 tons, valued at £12,115,807; the average being £3 10s. 8½d. per ton. The monthly quantities of the imports are interesting, as they show the strenuous efforts that were made to keep the country going with fuel during the run of the strike: January, 142 tons; February, 5591 tons; March, *nil*; April, 2818 tons; May, 450,162 tons; June, 1,390,824 tons; July, 1,389,981 tons; August, 167,133 tons; and September, 20,914 tons.

Coal Exported.

The quantity of coal exported last month was 3,406,759 tons; the value being £5,194,356. In Sept., 1920, 1,475,623 tons were shipped; the value being £6,622,515. Of the quantity exported last month, 413,475 tons are classified as gas coal, compared with 98,925 tons in Sept., 1920. In the nine months, 13,351,554 tons of coal have been shipped, carrying a value of £27,856,159. In the same period of 1920, 19,851,555 tons were sent abroad, with a value attached of £78,392,476. The quantity classified as gas coal during the nine months is 2,138,983 tons, as compared with 1,587,122 tons in the nine months of 1920.

Gas Coal Position.

We learn that some of the coal areas—Yorkshire and Derbyshire, for example—are distinctly busier than during immediately previous weeks in meeting an improved demand for gas coal. This is ascribed to the longer nights and colder weather inducing gas managers to keep a steady eye upon their stocks and purchases for safety's sake. The prophets are speaking of intensely cold weather coming; but whether it is or not, winter has its transport disabilities, and the principle of "safety first" applies to gas management as in other directions. Up North it is stated that there is still a drooping tendency in prices, but very slight.

NATIONAL GAS COUNCIL.

Meeting of the Central Executive Board.

A meeting of the Central Executive Board of the National Gas Council was held on Monday last week, the 10th inst., at No. 30, Grosvenor Gardens, S.W.—Mr. D. Milne Watson in the chair.

Railway Rates.

The revised rates now suggested by the Railway Rates Advisory Committee for the conveyance of coal, coke, and patent fuel, were submitted; and it was decided that further evidence should be given by the Council before the Committee.

Damage to Mains by Motor Traffic.

The damage caused to gas-mains in roads and main thoroughfares, owing to the increase in the use of heavy motor traffic, was discussed. The suggestion had been made to the Council that, inasmuch as the Roads Department obtained a large revenue from the licensing of such traffic for the maintenance of roads and highways, the Government should out of this revenue recompense gas and water undertakings for the losses sustained through broken mains, where it was proved that such mains had withstood the ordinary traffic for a long period. A Committee was appointed to consider this question and report.

Sulphuric Acid and Spent Oxide.

Correspondence between the Council and the National Sulphuric Acid Association, with a view to obtaining a reduction in the price of sulphuric acid, was considered. It was, however, disappointing to have to report that the acid makers had stated that, while they were keenly alive to the desirability of effecting a further reduction in the price of acid, this was out of the question at the present moment, as they maintained that the current selling price was below the cost of manufacture. The Sulphuric Acid Association asked that the Council should obtain information from gas undertakings as to the expected average weekly or monthly production of spent oxide for the next six or twelve months, and the various stocks held at different works. The Council, after collecting this information, will again discuss the matter at the next meeting of the Central Executive Board.

Gas Regulation Act.

Following the submission of a resolution from one of the Council's District Executive Boards, requesting that the Board of Trade be asked to endeavour to expedite the granting of Orders under the Gas Regulation Act, figures were given showing the number of applications already made for Orders under sections 1 and 10 of the Act, and of the number granted. The feeling of the meeting was that everything possible was being done by the Board of Trade to expedite the granting of these Orders.

Annual Meeting.

The date of the annual meeting was confirmed for Dec. 14, at 3 o'clock, at the Æolian Hall, Bond Street, W.

Yorkshire Junior Gas Association.—Under the presidency of Mr. G. Dougill, of Heckmondwike, the nineteenth annual general meeting of this Association will be held next Saturday, in the lecture room of the Fuel Department, Leeds University, when the election of officers for the new session will take place. At the close of the business meeting, an address to the members will be given by Prof. J. W. Cobb, C.B.E., B.Sc., F.I.C., &c.

Scottish Junior Gas Association (Eastern District).—The opening meeting of the session 1921-22 takes place in the Heriot Watt College, Edinburgh, on Saturday next, when the President (Mr. A. M'Donald) will deliver an address on "Difficulties on a Three-Quarter Million Works," and "Results from a 16-Million All-Tully Works." Mr. James Campbell, the Engineer and Manager of the Dunfermline Gas-Works, will read a paper entitled "Keeping a Grip on Things."

THE INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE ANNUAL GENERAL MEETING,

HELD AT THE

CENTRAL HALL, WESTMINSTER, S.W.,

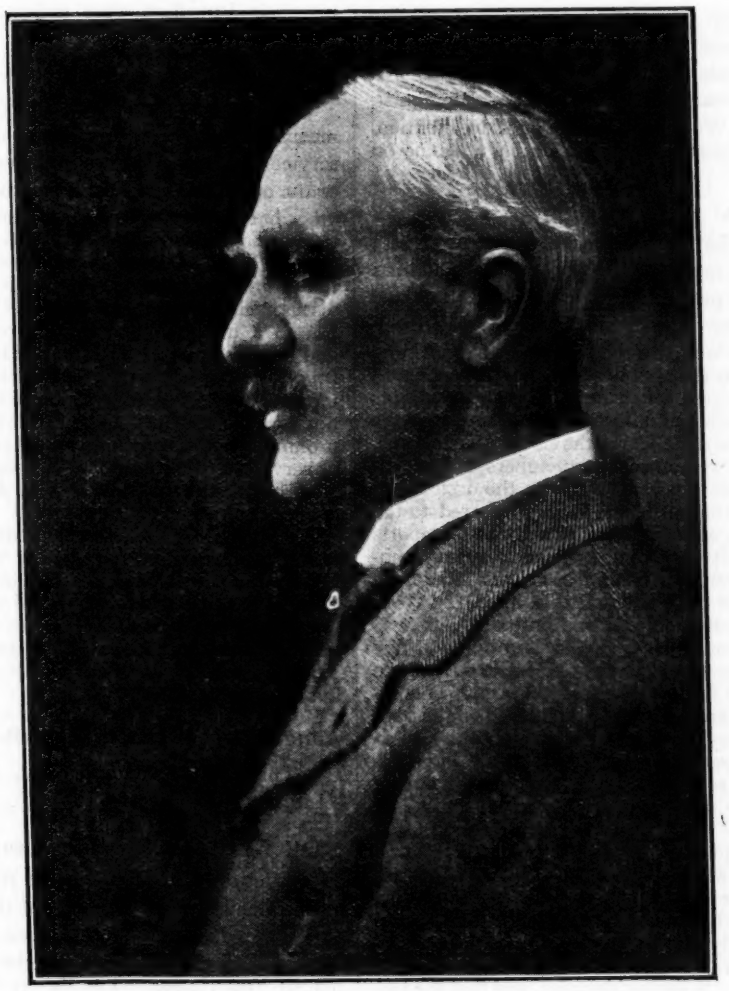
OCT. 11 and 12, 1921.

President: THOMAS GOULDEN, Esq., M.Inst.C.E.

REVIEW OF THE PROCEEDINGS.

[For Full Report see p. 188.]

NOTHING was lost by the deferring of the annual meeting of the Institution. A great deal might have been lost had the meeting been held in May last, with all the difficulties of the coal strike assailing the continuity of gas supply in practically every city and town in the United Kingdom. Although there was this adjournment to October, there was nothing more than an autumnal mist overhanging London on Tuesday morning to indicate that the year was so far spent, and even



THOMAS GOULDEN, Esq., M.Inst.C.E.

PRESIDENT 1920 21.

[Photograph by Fred Spalding, of Chelmsford.]

this indication cleared away as the morning advanced. But the temperature during the day was more suitable to May than to October. Just as everything appears to have gone out of joint lately in the industrial world, so the meteorological conditions have run far away from the normal line. The high temperature, which the Council of the Institution could not control, was the only subject of complaint heard; and in the Central Hall, Westminster—which is one of the best of

places in the Metropolis for bad hearing, and in such weather as we had on Tuesday for encouraging somnolency—the members found the conditions anything but agreeable. This again through the impossibility on the part of the Council to secure better accommodation on this occasion. However, there was a magnificent gathering of members from all parts. From every quarter of England and Wales, from Scotland, and from Ireland they came; and not drawn to London by the social side of the programme (because there was nothing so classifiable in it but the big reception and dance given by the President and Mrs. Goulden) but by the real solid technical business. It was all business, too, touching the times and the changes in the industry. There have been events of great importance to the industry since the members met in June of 1920; and naturally as technical guardians of the interests of the industry, they wanted to hear at first hand how things are shaping under these new conditions.

Sharply at ten o'clock the first morning, the President (Mr. Thomas Goulden) took the chair. He has had a long turn in the chair—four months beyond the normal, and this through the coal strike. By that much, the tenancy of the chair by his successor (Mr. Thomas Hardie) will be shortened. Mr. Hardie accompanied the President; as did the Council, Sir Dugald Clerk, Mr. H. E. Jones, the Hon. Secretary (Mr. W. E. Price), and the Secretary (Mr. Walter T. Dunn). There was a rousing reception for all from the vast body of members.

Visitors from Abroad.

Among those present from other countries at various times during the proceedings were M. Bertin, of the Paris Gas Company, and member of the Société Technique, Mr. A. Phillips, of the American Gas Association, Mr. Blomquist, of the Stockholm Gas-Works, and, we ought to mention, though an ordinary member, Mr. A. R. Burch, at home on holiday from Bombay.

Presidential Address.

There was a little formal business to be disposed of; and then the President read a short supplementary address to the one that he had prepared for the May meeting, and which was published by us on June 8. There was disappointment expressed by him over the enforced postponement of the meeting owing to the coal strike; and an expression of the deep personal regret which he feels that, during his year of office, due to the same unfortunate circumstance, he was unable to receive the members of the Société Technique, who so magnanimously welcomed the members of the Institution with other allies two years since on the occasion of the memorable visit to the battlefields. He referred to the publication of Sir George Beilby's paper and of the reports by the Research Committees. Since the address was published, the two Departmental Committees who have been investigating inerts and carbon monoxide have reported; and the President congratulated the Committees and the gas industry on their common-sense findings. As he said, any unnecessary restrictions would have gone far to defeat one of the main purposes of the Gas Regulation Act. The industry can now go forward practically unfettered on the path of progress. There may be a reconsideration of the question of inerts in three years' time; and this may have regard to carbon dioxide, seeing that this was shown during the inquiry to exercise decidedly prejudicial effects. The President got on to the subject of coal conservation; and this carried him to the question of electricity generation and use. There was acknowledgment of the mechanical advantage of electricity where power has to be distributed to a multiplicity of points, instead of being used at one centre. The President is strongly of opinion that, in the interests of coal conservation, the well-known report of the Coal Conservation Committee needs reconsideration, and that the two great industries should be so reorganized as to assist one another in the production of both gas and electricity. Reverting to the coal strike, which the President rightly describes as a national calamity, he calculates that the cost to the industry must have been between 3 and 4 millions sterling. Gas undertakings, in his opinion, deserve a large amount of credit for the way they carried out their duties during the distressful period. There was good witness for co-partnership; and it is a matter of regret that co-partnership is not more widely adopted in other industries.

The address ended, the veteran gas engineer and administrator (Mr. H. E. Jones) was at once upon his feet, and many handsome things were said by him as to the President and his work—especial emphasis being placed upon his responsibilities during the war, which he met with that unobtrusiveness and calmness which are part of his character. His services had been rendered not only to the great Company of which he is technical head, but to the industry as a whole. The vote of thanks which Mr. Jones proposed was seconded by Mr. D. Milne Watson, who has known Mr. Goulden as long as his own association with the Gas Light Company extends. He described him as an honest, capable man, who throughout all difficulties had kept his head, and whose heart and soul are in all modern movements. All these and many more good things that were uttered regarding their President were endorsed by the members with genuine cordiality.

Fifty Years' Service.

Half-a-century's service in one undertaking is by no means a record; but few men achieve it. Such a length of service speaks volumes. It shows contentment on the part of the one rendering such a length of service; and, on the other hand, it is the best of evidence of the satisfaction of those who are served. That is the case with Mr. Samuel Glover, of St. Helens. On his well-earned retirement from the position in which he has rendered such long, loyal, and distinguished official service, the Council of the Institution passed a unanimous resolution of congratulation to him; and this resolution they have had inscribed. It was a graceful act, followed now by its presentation in equally graceful terms by the President, which act and terms the members heartily endorsed, for Mr. Glover has always been one of the prominent members of the Institution, and a cheerful giver of service to the gas industry, which his Committee have ever aided and abetted him in doing. His has been in every sense an unselfish career.

As Mr. Glover rose to acknowledge the presentation, cheer after cheer went up, for to the members Samuel Glover is Samuel Glover. His words of thanks evidenced that he was deeply touched and sincerely gratified by the unanimous act, the words of both resolution and President, and the generous ratification by the large body of members. The best reward any man can have is the approbation of his fellows.

Annual Report of the Council.

This was next submitted, and was adopted—see "JOURNAL," for May 25 [p. 431].

Shall We Get a Reliable Recording Calorimeter?

After the discussion on the fifth report of the Investigation Committee, no member of the Institution would care to answer definitely this question in the affirmative—that is to say, a recording calorimeter sufficiently reliable for official prescription. The fact is the Act has ordained the use of such an instrument; and the Gas Referees, who are charged with the prescription of one, are not yet satisfied that a suitable one at present exists. Will one ever exist? We all hope so; but the outlook is too obscured at present to enable the giving of any positive answer.

The publication of the report of the investigation by Mr. James W. Wood, upon whose work richly deserved encomiums were passed, was commenced in the "JOURNAL" for June 22; and the contents are well known to all interested. Prof. Cobb presented the report; and Mr. Wood entered into it in somewhat more detail. The importance of accuracy

was emphasized by Prof. Cobb when he said that, taking a reasonable figure for coal carbonized in gas-works, and a therm price of 10d., it was calculated that, if all gas-works were steadily working at 1 p.ct. above the declared calorific value, this would involve an expenditure of £400,000 a year for the delivery of therms without payment. This is probably quite correct; but since gas has been supplied on some standard of quality, it has always been incidental to its supply that it has had to be made and distributed something above the ordained standard. Prof. Cobb gave no hope of success in designing a perfectly dependable recording calorimeter. In his opinion—and he is not very far wrong—the general impression that would be carried away was that the possibilities of error are so numerous and so difficult to eliminate that the designing of a perfect instrument is going to be an extremely difficult matter. Mr. Simmance was complimented by Prof. Cobb and others upon the degree of success he has attained. There were thanks to Mr. Wood, and to the Birmingham Gas Department and Mr. Rhead, the Chief Chemist, for the facilities afforded in conducting the investigation.

Criticism and Suggestion.

Mr. Simmance was there in response to an invitation; and he must have been gratified with the reception when he rose to speak, which testified to the appreciation of the gas men there of the value of the work that he has done in designing and in attempting to realize a perfect calorimeter. His remarks were both complimentary to the investigators but incisively critical of their conclusions under the conditions of the instrument and the research. The instrument works normally at 1/200th of an inch pressure; and the investigation dealt with gas of changing gravity, which is rather hard on the calorimeter. The calorimeter used was graded for London gas; and it had been running on London gas some six weeks quite satisfactorily. It was an old calorimeter designed in 1916. It was sent to Birmingham, and was put together and has been running, without assistance or advice. This is not so bad for an instrument of the kind; and Mr. Simmance claims that this alone is evidence of a distinct advance. The instrument graded for London gas has been used on mixed gas; and so altogether Mr. Simmance does not think that the report is quite fair to the instrument. His remarks and those of other speakers accentuate the difficulties occasioned by the chemical and physical characteristics of the water used. His whole argument went to show that only a recording calorimeter that is absolutely and invariably accurate is an instrument that can be used under the Gas Regulation Act. At the same time, Mr. Simmance says he is told it is possible to make such an instrument; but he has his doubts.

Mr. J. P. Leather, who uses moorland water, suggested the employment of distilled water cooled to proper temperature. Among other speakers was Mr. A. Blackie, of the Fuel Research Station, who has had a long experience with the Simmance instrument; and he finds it follows remarkably well changes of density, though it may not be correct for the higher densities. The burner of the instrument at the station used to get clogged; but since it has been altered there has been no trouble. He does not find the governing a serious matter; but the losses and gains through the walls of the calorimeter are much more serious. There has been trouble with the water owing to the fact that it contains a considerable quantity of unfixed CO_2, which forms bubbles. He also spoke of the variations in the room temperature. While he agrees that the instrument is thoroughly suitable for the control of manufacture, the question of suitability for penal purposes is one for the Referees. Mr. Fairweather described the instrument invented by his brother. Dr. Stewart and Dr. Davidson both appeared to think that a recording calorimeter, however perfectly made, could not be a reliable instrument for penal purposes; and that proper official tests should be carried out with the best instrument that would give the maximum results. Dr. Davidson, in fact, asserted that a large undertaking would lose thousands of pounds per annum if it trusted to a recording calorimeter. Prof. Smithells promised that a written reply should be made to the discussion; and the report was adopted. But not before the President had emphasized the point that gas undertakings would not have a recording calorimeter put upon them by the Referees without the fullest possible inquiry. He has the utmost confidence in the Gas Referees in respect of this particular matter.

Blue Water Gas Report.

Attention was next directed to the sixth report of the Gas Investigation Committee, which deals with the process of blue water-gas manufacture, and for the research work in connection with which Dr. A. Parker is chiefly responsible. Prof. Cobb presented the report, and again there was recognition of the courtesy of the Birmingham Gas Committee and their officials in placing plant and laboratory facilities at the disposal of the Committee. The report has already been published by us; a start being made with it on June 15. It deals largely with the thermal efficiencies and the losses in blue water-gas making; and, as Prof. Cobb says, it will assist those who are working such plant (the efficiency of which being intermittent is lower than with the continuous processes of producer-gas making or complete gasification) to ascertain the direction in which to look for improvements in their own practice. The report is complementary to the previous ones into the question of steaming in vertical retorts, both at Uddingston and Birmingham. There is a point which can be emphasized. It is that both the Committee and the Fuel Research Board appear to be convinced that, having regard to the character of the coal, steaming cannot be profitably carried beyond 20 p.ct. It was pointed out by Dr. Parker that his investigation of the blue water-gas plant gave him an average efficiency of 42 p.ct., making allowance for the raising of steam and the driving of the blowers. Without these allowances, the efficiency is 56 p.ct. This does not compare well with the extra gas raised by steaming charges in continuous vertical retorts. At the same time, the manufacture of water gas in an outside generator does possess certain advantages. Naturally, reference was made to increasing the efficiency by raising steam by utilizing the waste heat. There was comment by Sir Dugald Clerk on the low efficiency of the process, compared with gas-producers working continuously. Efficiencies of 80 p.ct. are obtained with producers; and 85 p.ct. has often been exceeded. He indicated that much higher efficiencies are possible in blue water-gas making. Mr. E. G. Stewart was the strongest critic of the report—pointing out that the Committee's efficiencies were low, because they have taken the gross fuel, and not the net. The investigators have allowed nothing for the coke in the refuse. He charged them with inconsistency in this respect; for what they have left undone in the blue water-gas tests in this regard, they did in the research into the steaming of vertical retorts at Uddingston. Then a second point he made has reference to the calculations for waste-heat boilers. He holds that the investigators are entirely "out of it." They estimated only 69 or 70 lbs.; while, on the basis of the Fulham experience, they could get something of the order of 120 lbs., which would raise the efficiency of 56 p.ct. up to (say) 70 p.ct. In Mr. Stewart's view, there is an example here of postulation *versus* performance. It will be interesting to see what the Investigation Committee have to say in their promised reply. In this connection, a study of Mr. Stewart's previous work on the question will probably be useful.

Refractories Research and Support.

The morning sitting ended with the consideration of the foregoing matters. At the opening of the afternoon sitting, the Refractory Materials Research Committee's report was presented by Mr. A. E. Broadberry, the Chairman. It will be remembered that the report [published in our issue for July 20] was divided into two sections. In the first Dr. L. Bradshaw and Mr. W. Emery dealt with "Jointing Materials for Refractories;" and in the second the same authorities treated of the "Influence of Oxidizing and Reducing Atmospheres on Refractory Materials." Those members who had not read the report heard an admirable exposition of its points from Mr. Broadberry. There is one matter that he rightly desires should be given due prominence. It is that industries and manufacturers are not giving that support to the Refractory Research Association which the material importance of its work demands; and he warns that, if there is not better support, the valuable work may fall. Improvements in refractory materials will benefit users to the extent of many thousands of pounds per annum; and this is obvious if Mr. Broadberry's estimate be accepted as approximately true, that in the gas industry alone no less than £1,500,000 is spent annually in the renewal and repair of retort-settings.

Filling the Pores of Retorts with Carbon.

An interesting experiment was referred to by Dr. Lessing in the discussion. In a note by Dr. Mellor at the end of the report, allusion was made to the results claimed by Dr. Lessing in a patent taken out in 1911, which results are said to differ from a phenomenon described by the investigators. One of the necessities in improving retort material is that it should be given a high porosity; and what Dr. Lessing set out to do was to effect a further improvement by filling the pores with solid carbon while the retorts are new. He experimented both with a fire-clay cylinder and with a retort in a small gas-works. The cylinder he exhibited cut through the middle. The process is to expose the new retorts in settings to crude gas under high pressure while heated; so filling the pores with carbon. The cut cylinder [a photograph of which we reproduce elsewhere] showed how effective was the experiment. The report of Dr. Lessing's remarks will be found to give fuller interesting information. He believes that with retorts *in situ* here is a ready means, with a small expenditure of crude gas, to save a large amount of gas later on, and to avoid the drawing in of inerts. Another contributor to the discussion was Mr. G. V. Evers, who says a retort material containing 81 to 82 p.ct. of silica is a sound proposition. Such material shows no shrinkage, and that is a very strong point.

Steaming in Vertical Retorts.

There was regret that Sir George Beilby was not able to be present at the meeting to submit the illuminating report on the experimental work that has been proceeding at the Fuel Research Station on steaming in vertical retorts, the publication of which began in our issue for June 8. But his assistant, Dr. C. H. Lander, took his place; and he gave an excellent *résumé* of the work. The research is a valuable one; and the results will be of considerable use as a guide in determining the extent to which one can go with steaming, using various coals of which the ones experimented with are representative. The discussion was highly interesting; but it covered so many points that in the main the full report must be left to tell the tale. There are, however, one or two points to which we may refer here. Attention was called by Mr. Thomas Glover (Norwich) to the fact that the figures show that, as the make of therms went up, less heat was absorbed in the process. One would, of course, expect the fuel consumption would rise as the gas output ascended. Apparently there is some reaction of which we know little. This is partly accounted for no doubt by the fact that part of the distillation in the upper portion of the retort takes place by the sensible heat of the hot water gas taken through the retort. This shows what an economical process is the steaming of vertical retort charges. He criticized the drop in ammonia which is not in accordance with practical experience. There was recognition by Mr. George Helps of the invaluable work that the Board of Fuel Research did when they made the recommendations that led to the passing of the Gas Regulation Act. Nothing has ever happened before in the gas industry to compare with it. But in regard to the paper, he regretted that there was nothing to show the commercial value. The point was made by Mr. Thomas Hardie that, from the figures in the report, it would seem that the much-prized (for vertical retort working) Yorkshire coal was more difficult to handle than Durham coal. His own experience is that, working at correct temperature, and throughput being in proper proportion, any coal can be carbonized in continuous vertical retorts. A close parallelism is found by Prof. Cobb between the results in the paper and the results in the Gas Investigation Committee's report on steaming. Both Prof. Cobb and Dr. Parker regret that no thermal balance-sheet is given in the paper, but only a weight balance-sheet. There were again references to the point that the results seem to show, as in the Investigation Committee's report, that steaming up to approximately 20 p.ct. possesses distinct advantages, but to go beyond reduces them. Engineer-Commander J. Fraser Shaw, R.N., Chief Engineer at the Fuel Research Station, and Mr. James G. King (Chief of the Laboratories) briefly commented on points raised in the discussion; but the full reply is to be made in writing. The former said it is a fact that less heat is required in the combustion chambers for the carbonization of coal with steam passing through the retorts, owing to the utilization of part of the heat of the coke; and Mr. King remarked that the chemical balance had been considered as well as the weight balance.

Efficiency in Horizontal Retort Carbonization.

We all know that the South Metropolitan Gas Company send out nothing but straight coal gas of high calorific power per cubic foot, and of low incombustible content. There was therefore great interest in having from the Chief Engineer of the Company (Mr. G. M. Gill) an account of the methods employed by the Company in working their horizontal retorts (which practically constitute the whole of the carbonizing plant), using coals from the Durham and Northumberland districts. There were no comparisons with other carbonizing systems in the paper, and no figures as to costs. It was simply a plain unadorned statement (with a splendid series of lantern slides to illustrate it) as to the methods found by the Company to be the best for attaining high plant and result efficiency. All members could agree with the two opening submissions of the author, which are axiomatic not only to-day, but at all times. These are the great need for obtaining the maximum duty from existing plant on account of the high cost of new plant; and the necessity of carbonizing coal to yield the highest quantity and quality of gas, coke, and liquid products. Some engineers may be disposed to put the second submission somewhat differently, by saying "to yield the highest quantity of therms, and the highest quantity and quality of coke and liquid products." Mr. Gill recognizes this, because he added that, arising from these desiderata, there is great need to make the coal gas of the highest quality compatible with the maximum yield of therms. To attain the highest efficiency in result, everything must be kept at the highest efficiency—plant, men, and methods.

There is a tendency in these times to limit consideration to types of machines that operate from one side of the house; but if these do not put charges into the retorts so efficiently as the old type of machines operating on both sides of the house, the accompanying advantages may be bought too dearly. That is not a positive statement; but it is sufficiently pregnant of meaning to raise an amount of controversy from several points of view. In approaching the general subject, it is well to get in mind the proportions of carbonizing costs. They will vary somewhat everywhere according to circumstances; but Mr. Gill puts forward the following figures as approximate as a good fundamental place from which to start investigation. Of every £100 spent in retort-house operations, coal takes £68; coke for furnaces, £13; upkeep, £9; carbonizing wages, £6; power and incidentals, £4. There we see the relative importance of the constituents of the total expenditure; and the order in which work should proceed to realize the maximum economy. The Company have periodical systematic inspections, based upon set standards of efficiency; and the inspections cost about 0·33d. per ton of coal carbonized.

From general considerations, Mr. Gill took us to details of the plant and processes. First, there are the producers. Too little attention is, as a general rule, paid to the maintenance of tight feed-openings to the producers; and much damage and waste of fuel can be traced to this cause. Clinkering-doors of producers are rarely formed air-tight; and at the Company's works provision is made against leaks in them. The importance of sufficient grate area is emphasized. Two-step grates are now used by the Company, which has substantially increased the grate area. Further improvement has been made by connecting the two bottom steps on each side of the furnace by a grating. By this means, the whole grate area is maintained in a lively condition. This has had a beneficial effect on the coke for sale under the conditions set out in the paper.

Settings Design, and Working Practices.

Considerable detail is given in the paper as to the construction of settings which shall have long life, and keep the retorts true and level throughout, with combustion chamber temperatures of 1300° C. For higher temperatures better materials must be used in the cross walls above the combustion chambers. The material should neither expand nor contract, and should be capable of withstanding a working temperature of 1350° C. for (say) 2000 working days, and the dropping down and picking up from cold. The silica content of such material as is found satisfactory in the Company's works varies from 86 to 92 p.ct. The funda-

mental principle of design has been the reduction as far as possible of the amount of retort heating surface covered by the cross walls. For many years, only 14 p.ct. of the outside surface of the retorts (21 ft. by 15 ft. by 20 ft. ovals, machine made), from end to end has been covered by brickwork. This design has been completely successful. The composition of the retort material is given. A particularly interesting feature is the statement showing the working lives of all the retorts pulled out during the past ten years, with the estimated amount of coal carbonized per retort life. The figures show an increase in working life and quantity of coal carbonized, until in 1919 the retorts pulled out had a working life of 2007 days, with 2288 tons carbonized per retort. The figures for 1920 were respectively 1948 days and 2281 tons. Incidentally, Mr. Gill urges the need for higher quality materials. The Company are making experiments in the use of unburnt clay and grog in building retort-settings. They have an experimental setting which has been at work for sixteen weeks, during eleven of which the combustion chamber was operating at a temperature of 1400° C., which led to the complete carbonization of the ordinary ten-hour charge in eight hours. There are no signs of failure yet. That by the way. The Company's retorts are each fitted with two 5½-in. ascension-pipes; and great importance is attached to this. With heavy charges, it is held that there should not be much trouble with stopped pipes if the hydraulic mains are kept free from accumulations of partly distilled tar, and if the pipes are properly cleared with augers of suitable design.

In working, the author defines a heavy charge as one that will occupy at least 66·6 p.ct. of the space in a new retort. The South Metropolitan practice with retorts, the dimensions of which have already been given, is 10½ cwt. charges, with a carbonizing period of ten hours. The make per retort is, of course, important in reducing the cost of manufacture; and variations in the charges are responsible for a reduction of efficiency. One cause of variation in charges is the size of the coal from the breakers. The speeding-up of the machines is also of importance—the work is done more quickly now than was formerly the case. The quantity of coal carbonized per retort per day has also an influence upon the quantity of coke made for sale per ton of coal carbonized. If a high output is being obtained from the retorts, the coke required for heating them is likely to be reduced per ton of coal carbonized. Mr. Gill went on to refer to several other details making for good carbonizing practice, in the course of which he dealt with the regulation of combustion chamber temperatures.

Inerts Reduction.

The Company have long had a good reputation for the low incombustible content of their gas. To this end, great care is taken to maintain mouthpieces and lids as tight as possible; and for this purpose the mouthpieces are re-faced whenever necessary. Tightness of mouthpieces, lids, and pipes is an important factor in reducing inerts. Regular tests and examinations are made to find out the leaks. The methods employed are explained in the paper; but for this review it is sufficient to say that it must be quite clear that leakages of gas which are disclosed when the plant is put under slight pressure become leaks of air when the pressure is again removed. Then there is also the prompt repair of cracks and holes in retorts. There is no doubt that a more thorough examination of the retorts in use in most retort-houses in the country would reveal a surprisingly large number of cracks and holes, all of which are a potential cause of high inerts. In the author's opinion, the first and most important step to be taken is to increase the therms made per ton of coal. The causes that bring about high inerts are the self-same causes which promote loss of gas. In the next paragraph, another cause of inerts and another means of reducing them is referred to.

Calorific Quality of Gas.

All these matters are contributory to gas-making efficiency and quality. We come into closer contact with calorific power in considering the question of working with unsealed dip-pipes. Since October, 1916, a large quantity of gas has been made by the Company in settings fitted with an arrangement by which the dip-pipes in the hydraulic main remain unsealed throughout the whole time the settings are working; the dips being unsealed only when gas making is stopped on Sundays and at other times. With this system the practice is to regulate the retort-house governors to maintain a level gauge in the ascension-pipes of such retorts as are open during a draw; and in this way no gas descends nor air rises in the ascension-pipes. When all the retorts are shut, it is the custom to regulate the governors to give such pressure, level gauge, or vacuum in the retorts as is necessary to maintain the desired quality. In ordinary working it is the practice to maintain a vacuum of $\frac{1}{10}$ in. in the foul main while the doors are open—thus giving a level gauge in the ascension-pipes and a vacuum of ½ in. while the doors are shut—this being found to be the correct adjustment for maintaining a quality of gas of a little over 550 B.Th.U. gross, with a normal quality of coal. Such a pull could not, of course, be exerted unless both retorts and retort-fittings were kept in a thoroughly sound condition. After instituting this system, it became apparent that it would be necessary to split-up each retort-house into units of four or five settings only, in order that the long pull could be worked for the maximum amount of time; and this has been done in several houses. By this means, the long pull is being worked for 90 p.ct. of the time, and the short pull for 10 p.ct. To split-up a retort-house into units, it is necessary to fit a separate retort-house governor to each unit, and to pass all the gas from the unit through this governor into the common collecting main from all units. Some 920 retorts are working under this system; and it is probable that the remainder will be converted in time. At one works, where the system has been in exclusive use since July, 1917, the total inerts have averaged 9 p.ct. only, which would seem to indicate, as might be expected, that oscillation (which by this system is avoided) is one of the causes of the admission of inerts.

Much on Calorific Value and Little on the Paper.

The discussion on the paper was deferred to the following morning, and was taken after the consideration of the affairs of the Benevolent Fund. Some of the speakers missed the whole point of the contribution, which was simply to give an account of the methods and practices of the South Metropolitan Company in operating their horizontal settings. In this regard, there was free acknowledgment of the value of the paper; but several members went adrift in some other matters. Mr. George Helps initiated this by a long opening contribution in which he stated that he had been sending out 250 B.Th.U. gas. He was led to this low figure during the coal strike. It is clear that, in his opinion, the South Metropolitan Company would do very much better by adopting his advice than by following their own considered methods. The fears as to the distribution of low-grade gas are also a bogey. Mr. Helps can show, practically dealing with 250 B.Th.U. gas, that the same initial pressure as when dealing with 500 B.Th.U. gas will do the trick. Of course, Mr. Helps may be right and he may be wrong in regard to the 250 B.Th.U. gas. Time will show. During the past few years, we have been getting on very well towards much lower thermal grades of gas by steady evolution without revolution, and the creating of chaos. He brought several members out showing inquisitiveness. There was the President, for instance, who wanted to know about the chemical composition of the inerts with the 250 B.Th.U. gas, and particularly the percentage of carbon dioxide. Mr. Helps could not off-hand give even approximate figures; but he said "as little as possible of carbon dioxide." He also added that, when he was sending out higher quality of gas, he had to carbonize 12,000 tons of coal brought 40 or 50 miles, while now he is able to satisfy his consumers by using only 2500 tons of local coal. When he can get the plant, the consumers will be receiving three times the "gas" for the same money. Someone wanted to know the price charged at Nuneaton; and it is 3s. 5d.! But in a month or two the gas industry is to be astonished by learning what can be done for the consumer. That is precisely what everybody is waiting to know. Mr. Helps is also going to indulge in a little missionary enterprise. To consumers through the country, he is going to demonstrate that they can receive three times the gas for the same money; and they will want it, and will have it. Among the doubters is Mr. Langlands, who does not believe ordinary distribution systems and meters will take anything less than 400 to 450 B.Th.U. gas. Mr. W. M. Carr and

Mr. P. S. Hoyte will be found among the sceptics regarding Mr. Helps's statements as to pressure.

There was an attempt on the part of Mr. W. H. Warren to bring the discussion back to the paper, and to the point of the methods to secure maximum efficiency from horizontal retort working. He commented upon the sacrifices Mr. Gill is making in using small retorts, and machines that preclude economical coal handling. His own experience at Beckton shows him that, though the retorts have more than 60 p.ct. of their surface covered by supporting brickwork and protecting blocks, they can do the work at 100° lower in the combustion chambers. The excessive supervision in keeping the retort mouthpieces, pipes, and retorts gas tight represents further sacrifices in the cause of efficiency. He does not think the successful working of a retort-house depends on an academic perfection; and a compromise, in his opinion, should be made between that and getting the greatest number of therms per ton of coal or per pound sterling. There were several other points in his remarks that will interest. There was also Mr. W. M. Carr, who asked whether we are not losing touch with the incidence of capital in relation to the saving to be effected.

We were taken back to calorific value by Mr. H. E. Jones, who correctly says that the war and the coal strike have taught us much. Among other things he has found is that the Wandsworth consumers are quite satisfied when they can get 450 B.Th.U. gas at a good pressure; and, if he had the distribution plant, he should not care to say that 400 B.Th.U. gas would be wrong. In time we may learn that the best gas to supply will be something between what Mr. Gill distributes and what Mr. Helps advocates; but the point cannot yet be fixed in the existing circumstances. Mr. J. Wesley Whimster (noted for cheap B.Th.U. at Bath, without high makes) criticized Mr. Gill's apportionment of the expenditure in a retort-house; but his comment covering several points requires the reader's reference to the full report. Mr. Tooms believes that the regular testing of retort-settings by technically trained assistants pays handsdown.

Though pressed for time, Mr. Gill, it will be found elsewhere, made an excellent reply. The whole moral of the paper is that the best must be made of the plant one has got until capital charges are again reduced. As to the quality of gas, had Dr. Carpenter been present he would have told the members that he is "sitting on the fence" like everybody else; and when he is convinced that a change should be made, he will do so as quickly as he transferred the South Metropolitan Company from cubic feet to therms. On all the other points, Mr. Gill kept his end well up. In thanking him for his paper, the President pointed out that the *crux* of the whole matter is the total cost per therm. In his view it would not do to alter one's methods too suddenly and drastically; seeing that all distribution systems have been laid down on the basis of the delivery of 14 or 15 candle gas. Reducing the calorific power too low to-day would mean running into endless difficulties.

Liberating Nitrogen from Coke as Ammonia.

Naturally gas engineers want to realize from the nitrogen of the coal they carbonize as much ammonia as possible. It was in 1918 that Prof. Cobb in the William Young Memorial Lecture dealt with the influence of atmosphere upon the products of coal carbonization. A certain amount of ammonia comes away easily by the simple application of heat in an inert atmosphere; but when the evolution has ceased, or even before that time, it is possible to obtain more ammonia if the atmosphere is changed to one which assists the process of making ammonia, or preserving it when made. In the next paper, Dr. A. C. Monkhouse, B.Sc. (Institution Gas Research Fellow) and Prof. Cobb, described the course and results of a study specially directed towards the further elucidation of this phenomenon. Prof. Cobb introduced the subject, and Dr. Monkhouse (who has just received the degree of Ph.D.) went into the details of the investigation.

Investigations into the subject have been made before; but it is seen that the authors have attempted to secure more definite and quantitative results with relation to three gases —nitrogen as inert (excepting in one special sense), hydrogen, and steam as potentially active in different ways. At a latter stage they propose investigating the influence of these gases on the production of ammonia from the beginning of coal carbonization. The present investigation was directed specially towards the comparative behaviour of the three gases named in influencing the further yield of ammonia when carbonization at a low temperature (500° C.) had been already effected. The authors mention the work that has been done before by Tervet, Beilby, Anderson and Roberts, and Christie. One of the authors investigated the action of various gases on coke in relation to the recovery of ammonia some years ago, using a coke which was much softer than a metallurgical coke, having been subjected to a temperature of some 900° C. He found that dry hydrogen did not liberate any large quantity of nitrogen from the coke as ammonia. The only gas to do so being steam, either alone or accompanied by hydrogen or nitrogen. The authors have attempted to throw some light on the somewhat conflicting testimony. Their method was to take a particular coal, and to coke it at three definite temperatures —500° C., 800° C., 1100° C., so preparing soft, medium, and hard coke. The action of hydrogen on these three cokes was then determined at three different temperatures—600°, 800°, and 1000° C. In order to differentiate between any specific action of hydrogen on the nitrogen compounds and the influence of an inactive gas, similar experiments were made, using nitrogen instead of hydrogen. Comparison with steam followed. The authors proceeded to describe the method of preparing the three cokes. In the analyses of the cokes given in the paper, it is noticed that the nitrogen diminishes as the temperature increases. In the coke produced at 500° C. the percentage of nitrogen was 1·87; in that produced at 800° C., the nitrogen was 1·34; and that produced at 1100° C., the nitrogen was 0·58. In analyses of the coke, calculated ash-free and dry, the respective nitrogen contents were 2·03, 1·46, and 0·61.

Taking the first experiment with 500° C. (nitrogen in coke 1·34 p.ct.) using nitrogen gas. In the balance-sheet given in the paper, the authors calculate to coke the nitrogen obtained as ammonia as 11·7 p.ct., the nitrogen left in the coke 60·4 p.ct., the nitrogen unaccounted for (chiefly as free nitrogen) 27·9 p.ct.

In the second experiment with 500° C. (nitrogen in coke 0·65 p.ct.), using hydrogen gas, the balance-sheet was as follows: Calculated to coke, the nitrogen obtained as ammonia was 34·2 p.ct.; the nitrogen left in the coke, 28·2 p.ct.; the nitrogen unaccounted for (free nitrogen) 37·6 p.ct.

These latter results show a very marked increase in the ammonia when using hydrogen—34·2 p.ct., against 11·7 p.ct. using nitrogen. Also that, while using the hydrogen, the fixed nitrogen in the coke was diminished to 28 p.ct. of that originally present, the corresponding decrease using nitrogen was very much smaller—60 p.ct. of the original nitrogen of the coke being left in it after treatment. From these two results it seems that the hydrogen with the 500° C. coke exercised a specific action on the nitrogen in the coke with the formation of ammonia in a stable condition—an action which nitrogen did not exert.

The next experiment was with 800° C. coke (nitrogen in coke 1·02 p.ct.), using nitrogen gas. Calculated to coke, the nitrogen obtained as ammonia was 0·3 p.ct.; the nitrogen left in the coke was 70·2 p.ct.; and the nitrogen unaccounted for (free nitrogen) was 29·5 p.ct. With the same coke using hydrogen gas (nitrogen in the coke 0·84 p.ct.), the nitrogen balance-sheet calculated to coke is as follows: Nitrogen obtained as ammonia, 3·9 p.ct.; nitrogen left in the coke, 59 p.ct.; nitrogen unaccounted for (free nitrogen), 37·1 p.ct. In respect of the nitrogen obtained as ammonia (3·9 p.ct.), the evolution was not completed. Treatment of the 800° C. coke with nitrogen gas at 600°, 800°, and 1000°, therefore, removed 30 p.ct. of the nitrogen in the coke. But if any ammonia was formed, practically the whole of it was decomposed, since only 0·3 p.ct. was recovered. The hydrogen gas removed 41 p.ct. of the nitrogen of the coke. Only 3·9 p.ct. was obtained as ammonia, but evolution at 800° had not ceased when the temperature was raised to 1000°, and later experiments demonstrated that a continuation of heating at 800° in hydrogen would have given much more ammonia. In other words the experiments show that the removal of nitrogen between 500° and 800° C. was greatest with hydrogen, least with nitrogen, and intermediate with crucible carbonization, and that nitrogen left in the coke is always more difficult to remove when the temperature is higher.

Coming to the experiments with 1100° C. coke, the nitrogen in the coke equals 0·58 p.ct. No experiment was made at this stage using nitrogen gas, but hydrogen was tried at 600° C., 800° C., and 1000° C. It gave no ammonia, and

after passing hydrogen the coke showed no diminution in nitrogen content. Therefore the hydrogen had not attacked the 1100° C. coke up to the temperature of 1000° C. It is a safe presumption that nitrogen would have given the same negative result. Summed-up the results showed that on a soft coke prepared at 500° C., the further action of hydrogen resulted in a considerable attack on the nitrogen present in the coke and the formation of considerable quantities of ammonia, recoverable because formed under stable conditions. With a medium 800° C. coke, the attack of hydrogen was less extensive, and the amount of ammonia recoverable smaller. With a hard 1100° C. coke, the hydrogen had no power of attack. The succeeding experiments was with 1100° C. coke using steam and hydrogen. Calculated to coke, the nitrogen liberated as ammonia was 5·7 p.ct.; nitrogen left in the coke, 87·9 p.ct.; and nitrogen unaccounted for (free nitrogen), 6·4 p.ct. It is seen that while hydrogen did not attack the hard coke using steam and hydrogen, a slow but steady evolution of ammonia occurred. The balance-sheet shows free nitrogen presumably from the decomposition of part of the ammonia formed.

Of course, the action of steam on coke with liberation of ammonia is well established, and is the basis of the Mond system of gasification. The next set of experiments was much more searching. Nitrogen, hydrogen, and steam were allowed to act in succession upon the same coke at 800° C. Nitrogen was first used; and this treatment was continued until no more ammonia came off. A stage had then been reached at which the formation and expulsion of ammonia were complete so far as an inert atmosphere could take it. Then treating with hydrogen more ammonia came off—ammonia which could not be obtained by an inert gas. This treatment was continued until the rate of ammonia production became quite negligible, at any rate for practical purposes. The hydrogen was then replaced by steam, and a further quantity of ammonia was obtained which it had been found impossible to get by treatment with either an inert gas or with hydrogen. The three treatments gave altogether 80 p.ct. of nitrogen in the coke as ammonia.

In the experiments parallel determinations of sulphuretted hydrogen were made. It was found that there is a parallelism between the results obtained with sulphur and those with nitrogen. By successive treatment with nitrogen, hydrogen, and steam, 93 p.ct. of the total sulphur in the coke was obtained as sulphuretted hydrogen.

More Investigation Needed.

There are lessons in the paper which it will be the duty of gas men to see whether they can apply in practice. This was emphasized by the President. Dr. Lessing would like the ash in the coke to be examined to ascertain its composition with the view to see whether there is any catalytic effect on the constituents of the coal during carbonization. It is feared by Mr. W. W. Townsend that it would not in ordinary working be possible by the application of the experimental methods to increase the ammonia very considerably within any feasible time; and he inquired whether the investigators had come to any conclusion as to the time required on an ordinary scale of working to carry out the reactions they described. In obtaining the extra yield of ammonia, there results extra sulphuretted hydrogen. The point made by Dr. Lessing is regarded by Prof. Cobb as quite a good one; and the information he desires is to be added to the report in the "Transactions." Concerning Mr. Townsend's points, the account of the investigations must be taken as having established certain facts, and from this stage investigation will have to be made for further information. As to more sulphuretted hydrogen being obtained, Prof. Cobb does not look on this with the slightest apprehension, because the sulphur obtained as sulphuretted hydrogen will come in for service for sulphate of ammonia making.

Tar Distillation.

The composite paper presented to the proceedings by the Society of British Gas Industries (a summary of which was next read by Mr. Fred. J. West) is divided into two parts—one dealing with tar distillation, the other with sulphate of ammonia manufacture. The paper is illustrated by no less than fifteen plates; and as a piece of literature dealing concisely with tar distillation and sulphate of ammonia manufacture by different plants, the contribution should be in the permanent possession of every gas engineer and gas chemist.

In the tar-distillation section, the Chemical Engineering and Wilton's Patent Furnace Company, Ltd., are the first contributors. Following Messrs. R. & J. Dempster describe the Dempster tar plant; Messrs. W. C. Holmes & Co., Ltd., the Hird distilling system; and Messrs. C. & W. Walker, Ltd., the Walker plant. This is a very opportune paper, as all gas managements are highly desirous nowadays of making the utmost possible out of their liquid secondary products. There is commercial advantage in dealing locally with the liquid products, as not only is money saved in the transport of useless material, but local demands are more easily met, and more money is made from the products. Every year the number of gas undertakings distilling their tar increases; and a large number of the smaller companies dehydrate their crude tar. This change has been brought about (as the Chemical Engineering Company point out) by three factors, two of which have already been noted: The desire for additional revenue from the secondary products; and the ready market assured by the greater demand for tar products and dehydrated tar. The third is that modern dehydration and distillation plants have made the processes very much simpler, and at the same time have greatly reduced the necessity for having highly technical supervision. We cannot here describe the plants in detail. But as to dehydration, this has become necessary for readily disposing of tar locally. Simplicity of design has endowed their functions with simplicity. Safety has been studied, and so has efficiency of heating with the view to a low fuel account. Maintenance costs have likewise been brought low. The Chemical Engineering Company have a preference for breeze or small coke as fuel. In respect of tar distillation, the three kinds of plant—intermittent, semi-continuous, and continuous, have individual advantages, according to the quantity of tar, its nature, and the labour conditions existing. With the Wilton plant, it is mentioned that the complete distillation requires one man in attendance to deal with (for example) 40 tons of crude tar per day.

In the description of the Dempster plant, it is held that the ideal plant is one which provides means for making dehydrated tar or completing the distillation at will. The intermittent system not only performs these functions, but enables any type of tar to be distilled without risk of mixed fractions; the "cut" being made according to test. The necessity is emphasized of giving due consideration to local conditions in the lay-out of the plant, in order to avoid unnecessary pumping of tar and fractions; and the condensers and oil-tanks should be erected high enough to allow the oils to gravitate into the tank-wagons. Other considerations are described in connection with the planning of the plant to avoid labour and promote convenience in working. There is good advice in all this. Though not essential, the use of a preheater is advocated, as it means a considerable saving in both fuel and time. Each part of the plant is fully described.

Explaining the principles and design of the Hird plant, Messrs. Holmes & Co. show that the chief features are: Cast-iron constructions where convenient, continuous operation with heat recovery, heating surfaces in readily replaceable form, and a simple system of temperature control. The complete tar-distilling sets are in four standard ratings: 20, 30, 50, and 100 tons per day. The means of heating adopted are both gas and breeze firing; but it is held that the former shows considerable advantages, particularly with regard to the saving of labour. The contribution deals in detail with the plant, and gives some useful information regarding the temperature steps in the circuit. The complete plant can be used for dehydration; but there is a design specially adapted for the purpose, in which coke firing is almost invariably utilized.

In their contribution Messrs. C. & W. Walker illustrate a plant which embodies their latest improvements in tar distillation to once-run fractions (without refining), including dehydration. The particular plant shown is capable of dealing with about 15 tons of tar per twenty-four hours. Again we have a description of the plant in detail from main still to pitch cooler. It is stated that the plant requires careful supervision, but is simple to work and safe in its working, and is capable of producing soft, medium, or hard pitch, and runnings from the secondary still can be made of dehydrated tar suitable for road-spraying purposes.

Sulphate of Ammonia Plants and Neutralizing.

The same firms in section two of the paper describe the latest forms of their plants for sulphate of ammonia making. The contributors are given the reverse order in this section; and so attention is first directed to Walker's sulphate plant. The firm submits, as a general proposition, that the most profitable method to adopt is to work-up residuals into valuable marketable products on the works. More especially is this so in regard to ammoniacal liquor, as the cost of transport, considering the amount of water in the liquor, is very considerable; and with higher railway rates in prospect, the transport question becomes more important than ever. Two plants are illustrated—one capable of producing 5 tons per twenty-four hours, the other 3 tons. The arrangements of the plants are identical. In each case neutralizing apparatus is included on the South Metropolitan plan. This provides for neutralizing the sulphate by means of condensing the vapours from the fixed ammonia portion of the still, diluting the solution of ammonia thus obtained until its strength is such that it loses practically no ammonia at the temperature at which it is used, and then treating the crystals of sulphate of ammonia in the centrifugal drier at 75° C.

It was the middle of last century that Mr. Cartwright Holmes erected plants for the production of ammonia, in which he employed for the distillation process an ordinary egg-ended externally fired boiler; the ammonia being absorbed in acid solution contained in a brick chamber, lead lined. The process was, of course, intermittent. From those days progress has been made in the plant supplied by Messrs. W. C. Holmes & Co., Ltd. The latest improvements have for their purpose the fulfilling of two paramount requirements: (1) To economize to the greatest possible extent, the consumption of steam, lime, cooling water, &c., and the labour necessary to work the plant. (2) To make it possible to maintain full output for the longest possible period of a run, and this without loss of efficiency, or the employment of an undue amount of skilled supervision. The paper gives the details of the plant, and the process of operation. In regard to neutralizing the product, the firm remark that there are at present in use two methods of neutralizing the salt as produced from the centrifugal drier. First is the Adam process, in which the sulphate is arranged in heaps, and subjected to impregnation by dry ammonia gas being passed into the heaps under pressure, and neutralizing the acid remaining. In the second, the crystals are treated in the basket of the drier by means of water and a weak solution of ammonia, two or three centrifuges being carried out on each charge treated. In both cases the gases are diverted from the fixed portion of the still, and condensed and cooled in a dephlegmating column or water-cooled condenser.

In their contribution, Messrs. R. & J. Dempster point out the necessity for sulphate of ammonia plant receiving very careful consideration, and emphasize the importance of attention being given to those details (often miscalled small) which tend to continuous and comfortable working. In their contribution they point out in some detail the most important matters that require consideration in a sulphate plant, dividing these under the headings of construction, working, and cleaning. Although these conditions number some two dozen, the firm claim that they are all embodied in the Dempster plant described. They submit that the plant is the result of experience gained through an appreciation of the paramount importance of a process that requires a minimum of expert attention. The neutralizing apparatus is designed to take the place of the drainer. It consists essentially of a circular tapered vessel with perforated bottom, into which the salt from the saturator is passed in a reasonably wet condition so that it will settle evenly. The vessel rests on a cylindrical shaped receptacle, so designed that any liquor or vapour passing into it from the vessel above does so through a central pipe. Two outlet pipes are provided, one near the top for suction, and one near the bottom leading to the saturator or well. The mother liquor is drawn from the salt by suction. The liquor forms an acid seal, and traps any ammonia (solution or vapour) subsequently drawn down from the draining vessel —returning it to the saturator either direct or *viâ* the well. From this point the method of working may be varied as each case demands. A wash with a small quantity of water may be given or a solution of ammonia may be applied; the excess being drawn through by suction, or a cover with flexible or jointed connecting pipe may be used, and the salt treated direct with ammoniacal vapours. If desired, this may be followed by treatment with steam. The paper also alludes to the manner in which the recovery of a washing solution of ammonia is carried out. The ammonia solution can be worked up to any desired strength, and just so much of it used as is necessary to neutralize the salt; a very small quantity generally being required. The liquid ammonia is stored in a tank at a convenient height for spraying the salt in the vessel first referred to, and after use is run from the receptacle beneath, either directly into the saturator or into the mother liquor well.

The contribution of the Chemical Engineering and Wilton's Patent Furnace Company, Ltd., opens with a reference to the advances that have been made in the process of sulphate of ammonia manufacture. In the course of this they refer to the "Wilton" automatic discharger, which was introduced by the late Col. T. Wilton during the time he was with the Gas Light and Coke Company. This automatic discharger is really an air-lift, with steam substituted for air. It discharges the sulphate from the top of a saturator, so that the mother liquor returns by gravitation without cooling, pumping, or ejecting. This innovation made possible the closed saturator, and was the foundation of the Wilton system. The paper refers to the chief points of a good installation of plant. The contributors mention that there is much to do in the future to improve existing work and the quality, chemically and physically, of sulphate. Alluding to quality, there is comment on the progress made in this respect. Now the sulphate may be produced entirely free from acid, and, where necessary, in the form of dry powder. The importance of this is accentuated by reference to the competition from abroad, and the immediate prospect of a new fertilizer at home. The facts constitute a definite call for improvement to ensure that British sulphate may be at least equal to the best article from elsewhere. The point is also made as to obtaining the maximum quantity of sulphate from the liquor and acid used. In the manufacture there are losses of ammonia, acid, and mother liquor. The sources of the losses are mentioned; and it is shown how they are practically prevented from happening in the firm's plant. Each item in the plant receives descriptive notice; and the contributors then refer to the process of neutralizing after whizzing. Briefly in the Wilton system neutralizing is carried out by running a charge of about 2 gallons of cold alkaline solution into the rotating basket. The alkaline solution contains free ammonia; and this combines with the free acid forming more sulphate. The actual amount of free ammonia necessary to neutralize a charge has been found to be less than the theoretical quantity; but this is due to the washing action of the liquid passing through the basket. In neutralizing the free acid, any pyridine which may be present is given off. The quantity of pyridine varies according to the method of working the saturator, and may be reduced to quantities that have not yet been found detrimental. In many cases there is no smell of pyridine; and this is probably due to the original freedom of the ammoniacal liquor from tarry matter. There are two methods of obtaining the alkaline washing liquor used in the Wilton system. The first is, concentrating and condensing a small quantity of ammonia vapour from a point in the liquor still, and adding the strong solution to cold mother liquor in a mixing-tank. The second is by a generator producing household ammonia from mother liquor and lime. This method is only recommended when there is a desire to sell the surplus for domestic use, or when it is found that the liquor is too weak or the liquor still not suitable for the first method. The tendency to make too much mother liquor in neutralizing has been overcome in the Wilton system by using saturated washing liquor, instead of a weak aqueous solution of ammonia.

Practical Experience with Tar Plants.

The contribution was correctly described by the President as an excellent "book of reference" with regard to tar distillation and sulphate of ammonia manufacture. It forms a valuable supplement to the contribution on carbonization which the Society of British Gas Industries made to the Institution proceedings in 1920. But there is a big hiatus between carbonization and the working-up of the liquid products, which it is hoped the Society will be able to fill up so as to complete the books of reference. A feature of the discussion was the relation of experience on the working of tar

distillation plants by Mr. S. A. Wikner, of Newcastle. He likes the continuous process. It is a beautiful one; and, when understood, it can be worked without much trouble. It is quite safe, which is more than can be said about the pot still. But he has unquestionably an affection for the double-pot still from the works' costs point of view, owing to the amount of work that can be got from it with only one man in attendance. The continuous still, too, though easily repaired, is rather expensive. There were several other points in his remarks, which he concluded by advising that small and medium-sized works should pool their tar; for there is greater economy in regular tar distillation. Testimony was borne by Mr. J. P. Leather to the ease with which the Hird tar plant can be worked; but he has not been satisfied with the amount of heat used, though he has reduced the quantity of gas consumed very considerably, by obtaining more perfect combustion in the heating tubes. A curious thing is that, though so much is said in the paper on sulphate making and neutralizing, the subject escaped attention in the discussion.

International Commission on Illumination.

Science knows no boundaries; and therefore it is well that there should be international agreements on terms, quantities, methods, measurements, standards, and what-not. This is what the International Commission on Illumination are trying to effect. On the Commission are representatives of several countries, Great Britain included. The Institutions of Gas and Electrical Engineers, the Illuminating Engineering Society, and the National Physical Society are all represented. Mr. Robert Watson is the representative of our own Institution; and he now made a report on the proceedings of the Commission, whose activities have until lately been suspended on account of the war. The report was of considerable length. It includes an historical narrative, showing what led up to the formation of the Commission; and then an account was given of the second session held in Paris last July.

On that occasion the British proposal was discussed for the official adoption, as the international unit of candle power, of the international candle as defined by the three national standardizing laboratories of France, Great Britain (National Physical Laboratory), and America in 1909; and subsequently there was adoption, with the following addendum: "This unit has been preserved by means of incandescent electric lamps by these laboratories, which remain charged with its preservation." There were reports and a good discussion by the representatives of the different countries on definitions and units; and "luminous flux," "luminous intensity," and "illumination" were all paraded and examined from the point of view of each country. A small Committee considered the terms, and produced a series of definitions, which were accepted with an amendment. As amended, the definitions will be found in the report by Mr. Watson.

From America a report was submitted on primary standards of light. The practical conclusion of the work is that one can adopt provisionally for the brightness of a black body, at a temperature of 2077° absolute, the value of 70·2 candles per square centimetre. This temperature is that at which the black body has the same colour as the electric lamps used by the national laboratories. The conclusions are not perhaps definite. But their publication will probably stimulate other experimentalists; and, after further investigation, it may be possible ultimately to determine the primary standard of light. Here we will by-pass the reports on heterochromatic and physical photometry.

Following papers on industrial and school lighting, some rules were adopted tentatively on lighting factories, mills, and other workplaces. These are given, with the minimum foot-candles required on the space or at the work. The American code for school lighting is also reproduced in the report. There is something to be said for the opinions of those who contend that legislation on industrial lighting should be confined only to safety, and not to efficiency lighting—the latter being a matter of variation according to working conditions and circumstances. A Committee are going to study the question generally, with a view to presenting a report at the next meeting of the Commission.

There is no question that the International Commission are doing very useful work, which will go far to promote scientific study and treatment of illumination. Mr. Watson's report is both comprehensive and intelligible even to those who have but scant acquaintance with the subjects dealt with. But scant acquaintance or otherwise, the importance of the questions will be generally admitted.

Home Office Report on Factory Lighting.

There was not much discussion on the report; but the President mentioned that the Council of the Institution were keeping in touch with the Home Office Committee dealing with the subject of the illumination of factories. A comment on the report of the Committee was made in the "JOURNAL" for Aug. 17 [p. 370]. The opportunity was taken to invite Mr. A. Phillips to give some information as to lighting experiences in America.

Life of Gas-Meters Joint Committee.

This report was next presented by Mr. B. R. Parkinson. It was printed in our columns on Aug. 17 [p. 377]. It will be remembered that it covered a wide range of topic. There is the continued investigation into chemical and physical causes of internal corrosion; a report on lubricating meters by spraying, and the effect on meters of introducing oil vapours into the mains; comparison of notes with a similar Committee of the American Gas Association; work with reference to the amendment of the Sales of Gas Act; and the tabulation of new standard sizes of meters with revised denomination. As to the last-named matter, the President mentioned that the new sizes would be ready before the end of the year. In seconding the adoption of the report, Mr. A. W. Glover expressed the view that all meters should be examined once every seven years. A question was put by Mr. D. T. Livesey as to the connections of meters being made to the sizes of iron pipes; while Mr. H. Kendrick suggested voltaic electricity as an explanation of some of the destruction that is going on. In a wet meter there are all the elements necessary—two dissimilar metals, and an acid liquid. There was comment by Mr. Thomas Glover ("S.B.G.I.") as to the beneficial effects of the inquiry that was started by the Joint Committee seven years ago, and how it has expanded to matters other than the one which was the original incentive to the inquiry. The investigation has tracked-down the trouble experienced to certain sulphur and cyanogen compounds in the gas. As to the question of oil-spraying, he warned that excess in this direction might have a detrimental effect upon the stuffing-boxes of meters. He suggests that a heavier oil should be tried than has been used up to the present. He acknowledged, too, how much in these matters the members of the gas industry are indebted to the President and the Gas Light and Coke Company.

Hydrocyanic Acid.

Others spoke, including Mr. Leather and Mr. Hoyte, the latter of whom wanted to know something as to how the work was proceeding in respect of a practical process for trapping that vicious compound hydrocyanic acid. To this the President replied that, as progress was made with the work on which Mr. Taplay is engaged, it would be reported through the Technical Press. In the reply to the discussion on his paper read later, Mr. Taplay gave some information as to the successful work that was being done with chalk broken to the size of hazel nuts, and used in a scrubber. The chalk in the scrubber will be washed occasionally with water, so as to present fresh surfaces to the gas. He is hoping soon to give the members a fresh "tit-bit" on this subject; but he wants first to be perfectly sure of his ground.

External Corrosion of Pipes.

It is not only internal but external corrosion from which pipes may suffer; and in a paper Mr. J. G. Taplay dealt with two forms of corrosion which he has recently investigated, and which took place, one in acid earth and the other in alkaline earth. One was a high-pressure steel service that was found badly corroded though wrapped in hessian and bitumen. The earth surrounding the pipe contained acetate of iron, together with dextro-glucose, and had intermingled all sorts of rubbish, including decaying vegetable matter. Calcium in various forms was also found, indicating the presence of bacterial action. A new pipe was

laid, and protected by hydraulic cement. As this may be considered costly, Mr. Taplay suggests that a heavier coating of hessian and bitumen might answer the same purpose. Regarding the corrosion of iron services in ground of an alkaline nature or iron fittings in plaster, water must be present to promote the deteriorating action. Investigation shows that in every case the corrosive agent is calcium bicarbonate. It has been found that this form of alkaline corrosion proceeds just as rapidly as does acid corrosion. The paper is extremely interesting.

The President had no idea until the paper was read that gas-pipes were subjected to so many dreadful conditions; and it is a wonder, in his opinion, that pipes last so long as they do. Mr. Leather related experiences he has had with pipes in clay soil; and the President with pipes at Beckton in made-up soil subjected to the action of brackish water. All the iron appeared to have been dissolved out of the pipes; and they were nothing but graphite pipes. It was pointed out by Mr. Taplay that very often clay will hold a lot of water; and calcium being in the clay with the water will do the trick.

New Honorary Member.

By the unanimous vote of the Council, and the hearty concurrence of the members, the name of Mr. Thomas Settle has been added to the roll of honorary members, for his pioneer work at Exeter in connection with vertical retorts. This is a richly deserved honour.

Miscellaneous.

A message was received from the Société Technique, conveying to their British colleagues assembled in London best wishes for their meeting. It was mentioned by the President that, at the next annual meeting, our French colleagues are coming over with their ladies; and for this and other reasons—one being Mr. Thomas Hardie's elevation to the presidency—London has been selected for the meeting. The Presidents of the Société Technique du Gaz, and the American and Italian Gas Associations, were elected honorary members. It was also mentioned that Sir Dugald Clerk has offered to collate, and pay the expense of doing so, the various papers he has written relating to the question of thermal efficiency. There was a vote of thanks for everybody who has been associated with the work of the Institution during the past year or rather fifteen or sixteen months, and with the annual meeting by contributions and so on.

An enlivening geniality prevailed during the transaction of these matters; and in this atmosphere ended the business proceedings of a meeting which has given all professional gas men many points associated with topics of current technical importance for further consideration, and perhaps direction in their daily work.

RECEPTION AND DANCE.

The reception on Tuesday evening, by the President and Mrs. Goulden, was an event successful in the highest degree. It was at the place of several previous similar happy gatherings—the galleries of the Royal Institute of Painters in Water Colours, Piccadilly. The acceptances for the occasion reached what we believe to be the record number of about 550; but, numbers notwithstanding, both the President and Mrs. Goulden stoutly stood their ground, and, with the utmost happiness and cheerfulness, received their guests as they came in pairs or singly. The stream for an hour or more seemed as though it was never going to end; but there was no tiring of the President and Mrs. Goulden—on the contrary, their pleasure seemed to expand as the number of guests grew. Then at length, when the formality was over, they moved about among their friends in the large room allocated to dancing, in the refreshment rooms, and the lounge. By the way, the suggestion that orders and decorations should be worn was duly observed. There were more of them than we expected—decorations of all kinds. And not by any means the least interesting on the President's coat was noticed the miniature of the medal of the Metropolitan Special Constabulary that was recently presented by H.R.H. the Duke of York. Roaming round, one came across the Right Hon. Sir Daniel Ford Goddard, Sir Arthur Duckham, K.C.B., Sir Dugald Clerk, Mr. D. Milne Watson (the President of the National Gas Council), Brigadier-Gen. Mowat, the Secretary of the Institution of Mechanical Engineers, and Mr. Harry E. Jones. Among the members of the Institution were members of the Society of British Gas Industries and of the British Commercial Gas Association, together with officials of every organization—all accompanied by their ladies. During the reception, there was music by Peacock's orchestra; and then dancing commenced. There was no lack of dancers; and our old friend "H. E. J." took his place on the floor in the one step, the fox trot, and other dances, with all the vim and gracefulness of youth. It was a happy evening. All were loth to quit, and not a few saw the programme of dances through to the very end. The hands of the clock were fast approaching midnight when the last of those who had indulged in the pleasures and reunions of the evening were leaving.

AT No. 1, CARLYLE SQUARE.

The Recording Calorimeters under Observation by the Gas Referees.

The kindness of the London County Council (with the assistance of the Gas Light and Coke Company) that allowed members of the Institution of Gas Engineers to visit the testing-station at No. 1, Carlyle Square, Chelsea, to see the recording calorimeters installed for trial by the Gas Referees, was greatly appreciated. The interest is shown by the fact that on the two days of the meeting something like 150 members visited the station. In addition to the Simmance, Thomas, and Fairweather instruments, there were also seen a Beasley recorder, and a Brady calorimeter—the last-named being not a recording instrument, but a means of obtaining a rough measure of the calorific value of the gas.

VISIT TO THE EAST GREENWICH GAS-WORKS AND THE FUEL RESEARCH STATION.

THE meetings of the Institution on Tuesday and Wednesday were technically highly interesting and instructive. Not less so were the visits paid on Thursday to the East Greenwich works of the South Metropolitan Gas Company and to H.M. Fuel Research Station, which has an independent place on the works, and is controlled only by the Director of Fuel Research (Sir George Beiby, F.R.S.), his colleagues, and his staff. It was extremely fitting that the members of the Institution should on this occasion have paid a visit to both places, in view of the papers by Sir George Beilby and by Mr. G. M. Gill at the meetings; and it was kind of the President of the South Metropolitan Company (Dr. Charles Carpenter) and his co-Directors and Sir George to invite them, and particularly generous of the former to entertain such a large number of visitors to lunch.

The acceptances for the occasions numbered some 450. Consequently there was great animation in Grosvenor Gardens between 9.30 and 10 o'clock on Thursday morning, when motor charabancs were lined-up there on both sides, and men were busily looking out for the vehicles bearing the letters in the particular groups to which they had been allocated. Mr. Dunn was there marshalling his big flock; and he did it so well that we were not much behind scheduled time in starting off on the journey to East Greenwich.

INSPECTION OF THE WORKS.

Arriving at the works we found the General Manager (Mr. F. M'Leod), the Chief Engineer (Mr. G. M. Gill), Mr. E. V. Evans, Mr. Thos. Curr, Mr. T. S. F. Gibson, and others looking after the reception and division of the big company into parties, each being properly labelled with a numbered button showing the party to which he belonged. There is one thing which all can admire about the assistants of the staff of the Company; and it is that they know their "jobs" so thoroughly that they make exceptionally good guides round any one of the stations. What we have experienced before, we experienced again on this occasion; and so the thanks of the visitors are due to one and all of these gentlemen for their services in making the inspection of the works

so interesting. They were: Dr. Anderson and Messrs. Andrews, Nash, Howes, Payne, Cox, Barnett, Thomas, M'Leod, Irving, Redwood, Wilkinson, James White, Frank White, Everett, Bulling, Kingsbury, Simms, Symonds, and Mitchell.

Everything was inspected—including the calalytic purification plant—from retort-houses to gasholders and district governors. From a neat brochure distributed among the visitors, we take the following general particulars:

The Company have six stations at which the manufacture of gas is carried on. These are known as Bankside, Greenwich, East Greenwich, Old Kent Road, Rotherhithe, and Vauxhall works, the total area of which is approximately 170 acres. The coal used for gas-making is principally from Durham. Some 60 p.ct. of it is brought by ships belonging to the Company (eight in all, having an average carrying capacity of 2150 tons) to the piers at the Rotherhithe and East Greenwich works, where it is unloaded by hydraulic cranes, fitted with self-acting grabs. At these two works, the coal is dealt with for the other stations. It is unloaded from the ships into barges and conveyed by the Company's tugs to the works at Bankside, Greenwich, Old Kent Road, and Vauxhall. The importance of the quick dispatch of the steamers may be gauged by the fact that a maximum of about 5000 tons of coal is carbonized per day during the winter months when the works are on "peak" load. In addition to this amount, provision has to be made to meet the holding-up of supplies from the collieries or possible difficulties in transport; and this is effected by the storing of coal at the East Greenwich and Old Kent Road works to the extent of 250,000 tons. The coal is carbonized in retort-houses, of which there are seventeen, mainly containing beds of horizontal retorts. Their aggregate gas making capacity is 357,500 therms per day. The carbonizing period in present circumstances is ten hours; and the average weight per charge is from 10¼ to 11 cwt. The maximum make of gas, and the coal carbonized per day at the respective stations, is shown by the following table:

	Coal Carbonized. Tons.	Gas Made. Therms.
Bankside	170	11,000
West Greenwich	170	11,000
East Greenwich	2300	165,000
Old Kent Road	840	58,000
Rotherhithe	640	41,000
Vauxhall	1000	71,500

Gas is stored in nineteen holders; the total storage capacity being over 46,000,000 c.ft. (253,000 therms). The largest holder is at East Greenwich and has a working capacity of 12,000,000 c ft. (66,000 therms). The central distributing station is Old Kent Road, which is connected by mains with the other stations. In the case of East Greenwich, the main is about four miles in length, and is constructed of 48 in. diameter cast-iron pipe. Transference of the gas is effected by means of non-positive fans of the Sturtevant, Buffalo, and Rateau type.

In the manufacture of gas it has been the practice to devote great care and attention to the maintenance of a high standard of efficiency in the retort-houses, which are subject to severe tests, such as putting under pressure for the discovery of leaks on ascension-pipes, doors, &c., detecting likely sources of loss in the hydraulic mains, compressed air, and hydraulic power plants generally, the time taken in charging and discharging retorts, the heats in combustion chambers, and other points of importance where loss in efficiency is likely to occur.

The Company make and supply coal gas only, which entails the handling of proportionally large quantities of residuals. During the year ending Dec. 31, 1920, these amounted to the following figures:

Coke. Tons.	Tar. Gallons.	Ammoniacal Liquor (8 oz.). Gallons.	Breeze. Tons.
743,982	11,248,838	47,466,864	125,958

The coke is sold into vans, ships, barges, and railway trucks; the maximum amount so dealt with during any one year representing 620,878 tons. The tar is lightered in tank-barges to the tar-works at Ordinance Wharf, where it is first distilled into primary products—the principal being pitch, anthracene, creosote oil, light oil, and naphtha. The liquor is also lightered in tank-barges from the various up-river stations and delivered to the East Greenwich Works, whence it is pumped to the Chemical Works at Phœnix Wharf for conversion into sulphate of ammonia. It is at this station also that the major portion of the spent purifying material used in the extraction of sulphuretted hydrogen from the gas is converted into sulphuric acid. This spent material is not usually sent from the works until the sulphur content has reached about 45 p.ct. on the wet basis.

The East Greenwich works is the largest of the gas-making stations of the Company; the total area of it being approximately 150 acres. The coal is brought to the unloading jetty by steamers carrying from 1000 to 4500 tons; the vessels are berthed at high water alongside the jetty, and are discharged at the rate of 2500 tons per tide. Four hydraulic cranes, fitted with self-acting grabs of 1½ tons capacity, unload the coal from the ships' holds, discharging it into storage hoppers having a capacity of 173 tons, from which it is removed by trains of fourteen wagons, each holding 5 tons, drawn by steam locomotives. The retort-houses, five in all (one of which only contains twelve settings), are 485 ft. long by 71 ft. wide, running parallel to the river, having 45 settings of ten retorts to each house, with an aggregate capacity of 165,000 therms per day. The capacity of each coal-store is about 1600 tons. The charging machinery in all the retort-houses is of the Arrol-Foulis type, the coke being discharged by Hunter-Barnett pushers, worked by hydraulic pressure. The time taken for charging the retorts averages approximately thirty seconds, and the discharging 28 seconds, per retort.

The gas is drawn from the retort-houses by six "Farey" type compound horizontal engines, working two exhausters each; thence passing to the Livesey washers, which are worked three in a set. These are placed at different levels, so that the liquor which comes from the scrubbers flows through by gravity, thereby saving the expenditure of power for pumping. Scrubbers are provided in sets of two or three, clean water being used for the extraction of the final traces of ammonia. From the scrubbers the gas passes to the purifiers, charged with oxide of iron—first, through the primary boxes, which are four in number, and measure 70 ft. by 30 ft. by 5 ft.; then to the sulphur extraction plant; and back to the secondary boxes, where the sulphuretted hydrogen generated as a result of the decomposition of sulphur compounds is removed. The gas then passes to rotary washer scrubbers for the removal of naphthalene. These washers are charged with anthracene oil, which is specially prepared at the Company's tar-works. The station meters are sunk in concrete tanks below the ground level. Special mention should be made of No. 2 holder, owing to its exceptional capacity. The construction of this holder was largely the outcome of the skill of the late Sir George Livesey. It has six lifts, two of which rise above the framing; the diameter being 300 ft., and the depth of the tank only 32 ft.

After the inspection of the works, the large company met again outside the Institute buildings attached to the works. On the green in front of the main entrance, a large marquee had been erected, in which were shown the numerous appliances upon which the name of "Metro" has been conferred. These appliances have secured enormous popularity in the district of the Company; and we know that further afield there are consumers of gas who have a strong preference for them. A great number of the visitors inspected the appliances. Subsequently, the whole party was grouped, on a portion of the enclosure, and a photograph was taken. It is interesting to put on record that this photograph was taken at the request of the United States Government; it being desired to add to the collection in the War Museum at Washington groups of members of those British Technical Institutions who specially assisted in the work of the Explosives Supply Department of the Ministry of Munitions during the war.

The Luncheon.

Very complete arrangements had been made within the Institute for the comfort and convenience of the visitors; and in the fine large hall the guests, numbering we believe some 450, sat down to lunch at the invitation of the President of the Company (Dr. Charles Carpenter) and his colleagues of the Board. The tables were attractively decorated; and during the luncheon the "Metrogas" band, under the conductorship of Mr. Sydney Herbert, played some beautiful selections of music. As hosts, the Company are as perfect as they are in their policy of conducting their manufacturing processes and methods of business. Dr. Carpenter, who presided, had with him at the same table the President of the Institution (Mr. Thomas Goulden), the President-Elect (Mr. Thomas Hardie), the Honourable Sir Charles Parsons, K.C.B, Mr. D. Milne Watson, Mr. H. E. Jones, Mr. W. J. A. Butterfield (one of the Gas Referees), Mr. Charles Hunt, Sir Arthur Duckham, K.C.B., Mr. Stanley H. Jones, Mr. A. F. Phillips, and several members of the Board of the Company, among whom we recognized Mr. F. H. Jones (Vice-President of the Company) and Mr. A. M. Paddon. The General Manager (Mr. F. M'Leod), Mr. Gill, and Mr. Frank Day (the Secretary) were also present, as well as various members of the staff of the adjoining Fuel Research Station.

After lunch, the Chairman gave the toast of "The King," and, while the hosts and guests were standing, the band played the National Anthem.

Trained Specialists for the Gas Business Side.

Dr. Carpenter said this was only an informal meeting; but, informal though it was, there was one toast he must ask those present to drink in order to make the proceedings complete. That was to join with him in drinking "Prosperity to the Institution of Gas Engineers." If there was any feeling in the minds of those present that, by doing so, they would be drinking more for their own pleasure than that of others, might he associate with the toast the name of the gentleman whose position he was not certain he quite understood—whether he was now Past-President, or whether he was still President of the Institution, but anyway he wanted to be allowed to associate with the toast the name of his old friend, Mr. Thomas Goulden. [Cheers.] At one time their orbits approached very near to each other; and if their respective stars parted on different journeys in somewhat different spheres of life, it was perhaps—he thought he might say—because fate had been kinder to him (Dr. Carpenter) than he deserved. With regard to the Institution, many of those present might need to be reminded that he (Dr. Carpenter) was, he thought, the last of that band of engineers—certainly the last on active service—who, some nineteen or twenty years ago, prayed the Board of Trade that they might be formed into an Institution for certain purposes. He thought besides himself the only one living was his old friend Helps of Croydon (as he always thought of him). He was sorry to feel that he was not there that day. However, it was interesting to look back and to refresh one's memory with the aims and ideals which the Institution had before it when it was formulated in those now getting rapidly distant days. One of its objects was to give opportunities for gas engineers to know each other more, to enable them to get together, and to discuss those matters which were then, as they were now, of importance in and to the profession. He thought he might say in every respect this ideal had been justified. It was also to give the opportunity by the

discussion of papers to improve their methods of working, and to raise them to a higher plane of efficiency, commensurate with the progress made in all departments of industry. He thought they might look back to gas engineering of twenty years ago, and say in that respect the position to-day, and the part the Institution had taken in it had in another sense justified the existence of their organization. Perhaps one of the greatest novelties at that time was the realization of the change which was coming about in the attitude of those concerned in industry as to the importance of adopting in all its departments reasonable and careful methods of research. In those days, it was made one of the ideals, one of the aims of the Institution, to do something to bring gas engineering into line with other important industries. In this respect, the Institution had every reason to congratulate itself upon what it had done. Through its means, through the interest it had taken in the present-day developments of gas manufacture, it had laid the foundation for gas legislation as gas legislation existed to-day; for he need not remind the members that the basis of the report of that important Committee charged with the duty of ascertaining the relative values of gas of different calorific duties formed the basis of the charter under which he and all of them were hereafter, or would soon be, working. [Cheers.] There were one or two other respects, one or two other ideals, which the Institution had in those days before it; and he thought that what he had already dealt with might be said to apply equally to them. It had maintained, it had improved, the standard of not only gas manufacture, but (he thought he might say it without any disrespect) of all those associated with the industry. No one could look back upon those twenty years, and not feel that the industry had now arrived at a period when the work of gas men was regarded with greater respect by the authorities and the public than was ever the case before. There were one or two other matters to which he felt tempted to take the opportunity of referring in making his speech on this occasion. He had said this was an informal gathering. It was not by any means to be considered a State function; and he might add that, when it was first talked about, he had no idea it would be of quite the character it had turned out to be. It was suggested by Mr. Dunn that, as the Institution were visiting the adjoining station of the Fuel Research Board (in the remarkable work of which he was sure the members must have been deeply interested), it would not be inappropriate to fill up a little time by visiting the East Greenwich works of the South Metropolitan Gas Company. But he (Dr. Carpenter) must plead guilty to feeling a little uncertainty about the suggestion, especially when Mr. Dunn said: "What have you got interesting to show?" Now that he (Dr. Carpenter) came to think over it, there was really very little of interest to show. He could not show, for example, the site of a super-electric power station at East Greenwich. It was true the electricians were very importunate in their suggestion that the time might come when they might settle at East Greenwich, and put down one of these superpower stations to use up the Company's waste fuel. He said to them: "But we don't make any." When they got to closer quarters, they had to confess, as he did himself, that the Company were not able to see a solution of the problem which, at the outset, appeared to have certain possibilities. Then he must make another apology. It was this. It was only within the last year or two they had been able (since 1914) to do a little to the works. He did not think the members could be otherwise than impressed as to this when they went round the works. They would see in them so many signs of neglect—rusting roofs and girders, and brickwork going to pieces—so many signs of neglect which he himself saw as he went round. It could only be a matter of time before they were in a position to correct these ravages of war. From the time when war broke out, they devoted themselves very completely and very thoroughly to other problems. One of the problems was that placed upon them by the Government, signs of which they might see in the adjoining buildings. He wanted to deal now with an aspect of things which perhaps appealed to him somewhat more vividly, to some extent as a looker-on, than it might to some of those present. Rightly or wrongly, he looked upon the carrying on of a business such as this and many others as having at the base something in the nature of warfare. He thought himself that the Darwinian theory was a fair expression of the principles on which this world was based, and, whether in industry, or in nations, it was the fittest that survived. For many years past, he had looked upon the carrying on of the business of a gas company as somewhat in the nature of warfare—warfare entailed by the fact that new industries and new people had arisen whose object it was to take away from them as completely and as fully as possible the business which had been theirs for something like a hundred years. If this simile was the right one—and he fully believed it was—he wanted particularly, if he might venture to do so, to draw attention to the part the Institution played in it, if they might revert for that purpose to a consideration of what had been happening in the world as a whole. In order to organize efficiently for warfare, it had been necessary to mobilize the engineering and the chemical forces of the land. In addition, propaganda had played a not unimportant part; and these three factors had been absolutely essential to enable the battles to be successfully won in those Northern provinces of France by those who gave their special attention to combats in the field. This was something like the position the gas industry was placed in to-day. The gas industry was in an analogous position to either the engineering industry or the chemical industry (as the case might be), both of which were so essential to the conduct of warfare, particularly in France. Now if they had followed him—if he had not been too involved in his reasoning—they would realize that the Institution of Gas Engineers had played an important part in providing what they might call the material of war or the munitions of warfare upon which the generals, their staffs, and the fighting men, had depended to achieve victory. He was somewhat under the impression that the realization of this had not been quite complete on the part of gas engineers. He thought this arose from the fact that this was a very old industry, having existed for something over a century, during the bulk of which time competition was either very small or negligible. What he wished to point out was this: If they were to hold their own, if they were to fill the place which he believed most firmly and sincerely they could fill, and not allow themselves to be ousted by others, they had to be as efficient in their fighting organization as they were in their organization for the production of material. This would involve the training and bringing up of another class of person connected with the gas industry from that to which they had been accustomed for many years past, because they would remember that gas undertakings were largely in the past, when they were without competition, conducted from within the gas-works, and not with the fullest attention to all that went on outside. He was particularly anxious this opportunity should not be lost by gas engineers because it did not happen to be gas engineering. He felt sure that there were many positions which might be profitably occupied by the sons and connections of those already associated with the industry who (while they might not be suitable from a technical point of view to conduct or manage gas undertakings as regarded manufacture) might be fully qualified to carry out another branch of its operations—that was, the business and selling side of the gas supply. For the reasons he had stated, it was much more easy to-day to find a suitable man to manage a gas-works than it was to find a suitable man to manage the district work of an undertaking. His belief was that the importance of the matter justified dividing-up the work and giving the care of the works to a technical man, and the care of the district to a business man. What he was anxious about was that this point should not be lost sight of by the members of the Institution, because he was convinced it was of great importance—just as the complete manufacture of munitions or of guns would not be an atom of good unless they had generals to lead the armies. He felt sure it was no use confining their attention to the manufacture of gas of suitable quality as well as residuals (if he were not an engineer himself he should be almost tempted to say it was of even greater importance) unless they ensured that the fullest possible advantage was taken of the product by the general public. He had ventured to mention this state of things for the reasons already given, and perhaps because, being something of a free lance, he could take liberties that everybody could not take who was not similarly placed. [Cheers.] That the Institution of Gas Engineers had in the past paid attention to these problems would be gathered from the discussions that had taken place over the various years of its history; but what he wanted those present seriously to consider was that the industry should take steps to be quite certain it had the best business organization for the product it made. He wanted to impress his belief upon those present that this could only be done by bringing into the enterprise of gas supply business people, and training them up in the work of gas supply in precisely the same way as it had been so long the custom to train-up men for the business of gas production and gas purification. With these remarks, he would conclude by asking them to drink with him the toast of "The Institution of Gas Engineers," with which toast he desired to couple the name of Mr. Thomas Goulden.

The PRESIDENT (Mr. Goulden) said he wished to express his fervent thanks on behalf of the Institution as represented by those present for the exceedingly interesting and kind words in which Dr. Carpenter had proposed the toast, and for the very cordial reception he and his colleagues had given them. He had known his friend Dr. Carpenter for a very long period of years. It was quite true that, although their orbits at one time touched very closely, they happened subsequently to be divided by a river; and they spread somewhat apart. But they were still working in the same profession of which they were both so proud. While he congratulated Dr. Carpenter on the eminent position he had attained in the industry, he himself could say with equally genuine feeling that his own path had been an exceedingly happy one. He had had the best of friends in his colleagues of the Gas Light and Coke Company; and, if he might say so, he had had the best of friends in, and had always had most cordial relations with, his Directors. He could assure them all that it would take a good deal to induce him to change his lot, even if he had the opportunity to do so. Speaking for the Institution of Gas Engineers, Dr. Carpenter had put before them all he (the President) could say about that organization. He had referred to the good work it did in the bringing together of members for the consideration of those problems which grew so rapidly in number, which they had to face at the present day, and were likely to have to face still more in the future. It was of inestimable value that they should be able to have conferences and exchange of views on all these subjects, when they had meetings such as they had so successfully held during the past few days. He personally heartily thanked the members for coming in such large numbers to the meetings, which he was a little bit afraid would have been spoilt by being deferred. He rejoiced that there was such a large gathering to enjoy the splendid hospitality that they had received at the hands of Dr. Carpenter and his colleagues. He wished to assure them how much they had enjoyed the privilege of looking over and inspecting these great works. The Institution of Gas Engineers had its special work, as an important educative influence. They desired very much to raise the quality of the gas engineer of the future, whose duties were becoming more and more specialized. It would be the work of the Institution to accomplish this in the greatest possible degree. They wanted men of the very best stamp to come into the industry; and he need not remind those present that it was an industry of which they could well feel proud, and one which deserved well of the country. One of the great objects of the engineer was to so develop the great resources of Nature that they might be applied to the comfort and convenience of man. If the gas engineer did not do this, he should like to know what member of the community did. The gas engineer dealt with the country's greatest asset—coal; and he dealt with it in an economical manner which was not approached by any other industry in the country. It was, he believed, the Premier who reminded them some time ago that this asset could never be replaced; and therefore there was the greater need for economy. The gas engineer so dealt with it as to administer to the necessities and the comfort of the nation. What greater necessity was there for the welfare of the nation than to render the atmosphere of our large cities and towns purer and more conducive to the health of the people; and no one did this to a greater extent than the profession which they followed. They had heard a great deal from scientific men lately—particularly from Dr. Saleeby—of the benefits accruing to health by a cleaner

and a clearer atmosphere. Those of them who lived in London knew very well how much clearer and brighter was the atmosphere they now lived in than formerly; and it made not only for health, but for cheerfulness of disposition, which was a material factor in the gaining of health. The enlargement of the gas industry's business had increased the health and comfort of the community generally; and therefore they could fully exercise themselves in the work of their profession, knowing so well that the extension of the functions of the industry was for the benefit of all. Dr. Carpenter had spoken about the part the industry had played in the war; and although they were not going to magnify their services, they must realize them. This was borne in upon them when they were called upon by their late President (Lord Moulton), and when they responded as one man to that call. Lord Moulton had himself repeatedly and most generously acknowledged the debt that he, as Director of Explosives Supplies, owed to the industry. They gave him what he asked for; and it was a material thing in the early days of the war, when the sources of high explosives had not been developed for their manufacture, that they were able to do what they did. Their soldiers and their sailors played their part nobly, and at what cost they had learnt to their sorrow. But it was the part of the industry to supply them with the munitions they needed so badly in the early days of the war; and the industry gave them these munitions to the full. They were all proud of this; they were all proud of having been in the position to serve their country so well in war as in times of peace. They provided the raw materials to many industries which were necessary for their existence; and the fact that they were able to supply them from within the country, without having to import them, was a very material matter in the restoration of that prosperity to which they were all looking forward. It was strongly recognized by them all that it was necessary for them to apply to their work that of the pure scientist, and to encourage the research of which Dr. Carpenter had spoken, and which must perforce lie in the hands of specialists. The gas engineer was a very complex sort of individual. He had to be a mechanical engineer, and he had to conduct very delicate and very complex chemical reactions in the course of manufacture; and following that he had to be a business man. This all made for complication, which could not go on if they were to conduct their business with that efficiency to which Dr. Carpenter had referred. He agreed that they must separate the purely scientific part of their work, and the inquiries into all the problems that accompanied the decomposition of coal, and put them into the hands of pure scientists—such as they had in the *personnel* of the Leeds University staff. It was to these gentlemen that they must look for the lessons which they, as mechanical engineers, must apply to their works; and it was for them to apply them in the best possible manner. The Institution, as he said, was encouraging research to the utmost of its ability and capacity, having regard to the funds at disposal. That their research scientists were doing good work had been shown by the reports and papers which had been presented at the meetings which finished the previous day. He did not think he really need say any more, except to assure Dr. Carpenter and his colleagues that the Institution would be (aided by new members of the Council, and by the younger members of the industry) certainly going forward with the utmost possible speed in the new path allotted to them. He did not believe in revolution, but rather in evolution; and the industry was in the path of evolution at the present time. The members of the profession might not at the present time possess one view with regard to calorific value. This was quite clear. They wanted time to settle down, and to find out what conditions were best suited to their consumers, and were best suited to their individual cases, and to ensure these conditions being gained at the least possible cost per therm. It was the business of the members of the Institution to supply cheap gas suitable to the purposes of the consumer, and at the same time to economize coal as far as possible. This in a nutshell was the problem before them. The Council and the members of the Institution would carry-out to the best of their abilities the duty of encompassing this very desirable end. Again he thanked Dr. Carpenter and his colleagues for their exceedingly kind reception.

The Carpenter Test-Burner a Bridge.

Mr. H. E. Jones said he was sure they would all like him to thank their hosts of the South Metropolitan Gas Company, as personified in the talented President of the Board, Dr. Carpenter. They had heard a great deal about how valuable research was. One of the important features of the administration of the Company was the precise care given to all things in connection with the Company from the manufacturing processes through to the apparatus which was sent to the consumers in the most perfect form and condition. If they did nothing more than walk through the works, and see with what scientific ability these things were attended to, they would readily understand how things were made much easier for the business man of the Company in making the consumers happy and comfortable. All this came from the research of which their Chairman had conspicuously proved himself to be a master. His name would go down to all time as a celebrity by having found some years ago a burner for testing gas which gave it its full and accurate value in respect of illuminating power. For this the whole gas industry owed to Dr. Carpenter something which, if it could be expressed in money, would be simply astounding. Ten years or so ago, Mr. Charles Hunt and himself, for their respective companies, took the step to change from illuminating power to calorific power; and very well they had found it suit their purpose. They had then the great advantage which they never possessed before, of having had a burner which would burn their gas to the best effect. If they had not had the burner, they would never have induced Parliament at that time to have allowed them to supply gas of less than probably 600 to 620 B.Th.U. The burner was the bridge which made it possible for them now to supply their consumers with something they could burn in their fireplaces and cooking stoves, as well as by which to illuminate their premises by the Welsbach mantle, without blacking ceilings. However, the whole industry was indebted to Dr. Carpenter for this, and for very much else which time would not permit him to dwell upon. That afternoon, too, they owed him and his colleagues their thanks for the spirit and graciousness which prompted them to ask them there to break bread with them. [Cheers, followed by heartily singing. "For he's a jolly good fellow."]

Gas Officials and Directorships—Exit the Sliding Scale.

Dr. Carpenter said he could not allow them to go without expressing for his colleagues of the Company, for whom he was the mouthpiece, their sincere thanks for the warmth of the reception their visitors had given them. They had, as a Company, done what they could for the industry. If there was one part of which he was more proud than any other, it was (if he might be allowed to refer to it for a moment) the new basis on which they had re-established their business. They had in their new Act of Parliament a proviso that the future members of the Board should be gentlemen who had some commercial, technical, or scientific knowledge which would be of advantage to the manufacture of gas and the business of gas supply. He felt sure this would go home to a great many present who had been troubled by a lot of old fossils and candlestick makers [Laughter] who had no business on boards of directors. In this respect the Company had set an example which should be copied. They had also said that the chief and deputy chief of the undertaking should be someone who had personal practical knowledge of the manufacture or distribution of gas. In this they had set an example with which no one could find fault, and which would appeal to everybody who had the interests of the industry at heart. They had set an example by which these positions in the administration would naturally fall to the lot of those who had spent their lives in following the honourable profession of gas engineers—should fall to the lot of those to whom no one could deny they had every right to aspire. In this respect he thought the Company had done something to improve and extend the status of gas engineers. Then he wanted to say one other word with regard to the financial basis of the Company. As they knew (he spoke with great delicacy in the presence of Mr. Jones, who, by the way, had made him feel exceedingly hot and uncomfortable), the Company had knocked on the head the sliding-scale, which he had looked upon for some time now as a pack of cards which was very useful for performing tricks before parliamentary committees and local councils. They had put their business on a basis which acknowledged that just as labour was entitled to fair wages, so capital was entitled to fair remuneration. That by their Act was fixed at 5 p.ct. for the old capital and 6 p.ct. for the new; and whatever profit was made in addition was shared equally between labour and capital. He did not say this was applicable to every case; but as a principle he firmly believed it was not only capable of being applied to the gas industry, but to other industries throughout the length and breadth of the land. There were also differences of opinion regarding the presence of working men directors on their boards. The Company's working men directors were quite pleasant companions; and when they talked to them, they would not be able to distinguish them from other members of the staff. They would find that their knowledge of gas affairs, gas administration, and even gas finance was on quite a broad foundation. In conclusion, the Chairman announced that, when the room was cleared, tea would be prepared for those who desired it before leaving. Also that those who cared to see on the screen part of a film the Company had prepared for propaganda purposes would have an opportunity of doing so. Their basic idea was this, that some proportion of those who burned gas in South London had no idea of the magnitude and importance of the gas industry. Another intention was to show them there was in their very midst a highly organized industry, employing a great many skilled men who were doing their best to supply one of the important necessaries of life. He thanked all present for the earnestness and enthusiasm of the welcome to his colleagues and himself that afternoon.

The Propaganda Film.

Before tea was served, a large number of the guests again repaired to the large hall to witness the cinematograph film prepared by the Company for propaganda purposes. It is well conceived, opening with scenes outside and inside one of the Company's suburban showrooms. Round the various departments you accompany a young couple who have "risen" to the lure of gas and intend, so it would seem, to indulge in an "all-gas" house. Interesting views have been taken of the fitting, assembling, and testing shops in the Old Kent Road. The actual or prospective consumer, when he sees the film, will be most surprised (many present on Thursday even were) at the *finesse* lavished to obtain efficiency. Pictures of the industrial laboratory and showroom led to many others of great interest figuring their industrial appliances out in the district, and saving money, time, and labour.

The Fuel Research Station.

The proceedings had lasted rather longer than the pre-arrangement; and therefore many of the visitors who had been anticipating the pleasure of a visit to the Fuel Research Station had to forego it. But still a goodly number were able to go; and they were very grateful to the Director (Sir George Beilby) and his colleagues for the opportunity thus afforded them, and not less to the staff at the station for the interesting information they imparted. Those who were able to visit the station knew how much interest those who had not been able to do so missed in not inspecting the work proceeding (including steaming in vertical retorts) in this important national enterprise, in which gas and other carbonizing industries, as well as fuel users generally, are so immensely concerned. Some references to the work of the station were made in last week's issue of the "Journal;" and in the number published on July 6, an account was given of a previous visit paid by a comparatively small number of members of the Institution.

GENERAL REPORT.

The Annual General Meeting of the Institution was held on Tuesday and Wednesday of last week, Oct. 11 and 12, at the Central Hall, Westminster—Mr. Thomas Goulden, M.Inst.C.E. (the Chief Engineer of the Gas Light and Coke Company), presiding.

The President's Greeting.

The President, on rising to greet the members, was received with loud applause. He said: In the first place, I should like to express the great regret of the Council that they have not been able to get for this occasion either of our usual meeting places—the hall of the Institution of Civil Engineers, in which we should have felt quite at home, or that of the Institution of Mechanical Engineers. Both of them happen to be engaged; and this we shall have to accept as one of the evils arising out of our having had to defer our meeting. We are lucky really, having regard to the existing state of affairs, in being able to get this hall.

Confirmation of the Minutes.

The President: The first thing is to confirm the minutes of the last annual general meeting.

On the proposition of Mr. W. C. Jones (Brierley Hill) the minutes were unanimously adopted.

New Members.

The President: I have to announce the following result of the ballot for the election of new members. Other elections have been published at intervals in the Technical Press.

Members.

Askew, Leonard, Chief Managing Assistant to Mr. A. F. Phillips, 82, Victoria Street, S.W.
Campbell, James, Engineer and Manager, Gas-Works, Dunfermline.
Danielson, Axel, Engineer, Distribution Department, Gas-Works, Stockholm.
Dunn, Clarence, Engineer and Manager, Gas-Works, Blandford.
Gibson, J. W., Engineer, Manager and Secretary, Gas-Works, Budleigh Salterton.
Hoult, H. K., Manager, Gas-Works, Bordon, Hants.
Humphrys, L. G., Engineer and Manager, Bexhill Gas and Water Company.
Imbrie, W. J., Engineer and Manager, Gas-Works, Yeovil.
Irving, D. F., Shift Engineer, South Metropolitan Gas-Works, East Greenwich.
Jones, B. F., Manager, Gas-Works, Emsworth.
Lawton, C. A., Engineer and Manager, Gas and Water Departments, Milford Haven.
Leonard, Arthur A., Manager and Secretary, Gas-Works, Iron Bridge.
M'Crae, J. P., Assistant Engineer, Gas-Works, Derby.
M'Gregor, R. H., Engineer and Manager, Gas-Works, Brecon.
Mitchell, Barker, Engineer and Manager, Gas-Works, Bangor, co. Down.
Payne, W. E., Engineer, Bankside Station, South Metropolitan Gas-Works.

Associate Members.

Hodder, H. J., Assistant Engineer and Manager, Gas-Works, Hampton Wick.
Jennings, G. L., Deputy Chief Inspector, Gas-Works, Brentford.
Kinneir, H. H., Assistant Manager, in charge of Gas-Works, Great Western Railway, Swindon.
M'Nally, Alfred, Assistant Chemist, Portsea Island Gas Company.
May, H. V., an Assistant Engineer and Manager, Gas-Works, Bombay.

The President's Opening Remarks.

The President: I have already written one address, which you may or may not have become familiar with through the agency of the Technical Press; and I do not now propose to bore you with another. But we have progressed a little since I wrote my address and it was published in June; and therefore I will ask your kind consideration for a few remarks which I wish to make.

The Unavoidable Postponement.

In opening the proceedings of our Institution to-day, I must first of all, after extending to you a hearty welcome and my sincere wishes for the success of the meeting that we are now commencing, express the deep disappointment of members of the Council at the necessity of having had to postpone until now the meeting that should have taken place in June last. In common with the other members of the Council, I was most unwilling to abandon the June meeting; but the stress of events accompanying the deplorable dispute in the coal-mining industry, which has resulted in such infinite harm to the country, at last made postponement inevitable, if we were to have anything in the shape of a representative gathering. I am sure that every member of the Institution will have shared in the regret of the Council at being compelled to defer the meeting, and in my own particular regret that, arising out of the postponement, the pleasure has been denied me of welcoming during my year of office the members of the Société Technique de l'Industrie du Gaz en France, together with their ladies, who had accepted our invitation to attend the June meeting. We had made full arrangements for returning to the best of our ability the hospitality which the Société extended to us two years since, which I had the honour, as Vice-President of our Institution, of sharing with a considerable number of our members. We were then entertained in Paris by the members of the Société, and by their good offices were able to visit the battlefields north of Arras and Rheims, as well as other places of less warlike interest, including the excellently equipped gas-works from which Paris is supplied. The extreme cordiality of our welcome, and the unobtrusive care that our hosts showed in everything that made for our comfort and convenience, will not readily be forgotten; and we shall not be quite happy in our minds until we have enjoyed their return visit, and practically demonstrated to them that our visit to France still remains with us a very grateful memory. Members of the Institution will welcome the intelligence that, though the members of the Société Technique are not able to attend the deferred meeting for which we are now assembled, their visit is only further postponed until the June meeting of next year, when I am convinced the welcome we shall give to them will only be all the warmer for the regretted delay.

Its Effect on the Programme.

The postponement of the meeting has naturally had its effect on the programme of our proceedings. I felt strongly, and the Council shared my opinion, that it would not have been either fair or courteous to the members of the Institution, or to those gentlemen who had given us the benefit of their knowledge and labour, to have withheld until now the reports prepared for the June meeting; and accordingly they were published in the Technical Press, in order that the gas industry, for the benefit of whose members the reports had been prepared, should have the information contained in them at the shortest possible time after they were due to appear. The substance of the reports has thus been at the disposal of members for some time past; and I trust that a more thorough discussion will thus be possible than if matters had followed their normal course and the reports been only placed in the hands of members immediately precedent to their being presented. For similar reasons the valuable paper, which in itself is a full report on the working of vertical retorts at the Fuel Station of the Department of Fuel Research, that by the courtesy of Sir George Beilby, the Director-General of Fuel Research, was to have been presented at the original meeting, was, with the assent of its author, published, in order that the industry should not be prejudiced by unnecessary withholding of valuable

information. In the case of this paper, as well as of the reports published, a fuller discussion will be expected than would otherwise have been probable. The publication of the Presidential address prepared for the June meeting was also decided upon, and you will long since have become familiar with its contents. I do not propose to make further reference to it, except with regard to one or two points in respect of which matters have developed since it was written and published.

The Inerts and Carbon Monoxide Committees.

At the time of drafting my address, Departmental Committees of the Board of Trade were, in accordance with the provisions of the Gas Regulation Act, taking evidence on the two respective subjects of the degree, if any, to which "inerts" in town's gas should be restricted, and as to whether or no it might be considered desirable to limit the proportion of carbon monoxide present in town's gas. The evidence put forward on both subjects on behalf of the Institution was that of engineers practically acquainted with the subjects on which they were examined; and both the gas industry and the public are to be congratulated on the common-sense findings come to by both Committees.

Town's gas has now become so much a necessity in the home for the purpose of furnishing the means of light and heat, and its use is so extensive for manufacturing purposes that any unnecessary restriction would have gone far to defeat one of the main purposes of the Act, which was to give members of the industry freedom such as they never before possessed, under defined conditions regarding the consumer, of themselves deciding (out of their own experience) as to the quality of gas they may judge best to supply, and the power of varying their method of manufacture according to local conditions, so that their consumers should have the benefit of gas supplied at the lowest cost. That both "inerts" and carbon monoxide should be restricted was pressed upon the Committees dealing with these two questions. But the evidence for the gas manufacturing side was emphatic as to the undesirability of the restrictions asked for; and as the result of the Committee's decisions, the industry can now go forward in the path of progress free from the hindrances that, with what we believe to have been mistaken ideas of the public advantage, were sought to be placed in the way. Any other decisions would have been regrettable, especially at the present time, when the necessity for the avoidance of anything in the nature of waste is so potent, and when it is so palpably incumbent upon us to use every effort to supply the consumer at the absolute minimum of cost.

The Carbon Monoxide Committee fully recognized the fact that the thermal efficiency of the manufacture of gas, in which our industry has already shown to so much advantage, is capable of considerable increase by the gasification of coke, with resulting increased content of carbon monoxide. The extent to which carburetted water gas is used in the United States of America—even to 100 p.ct. in some of the most important cities—clearly indicates the chimerical nature of the objections that were put forward for the limitation of carbon monoxide, which I may be permitted to remind members is most valuable in use, owing to its high flame temperature and the relatively small amount of air necessary for its combustion.

With respect to the decision of the Committee on "Incombustibles" that "inerts" should not be officially restricted, I would draw the attention of members to the fact that this subject may in three years' time again come under consideration. The reports of the researches of Dr. Cobb and the Leeds University staff were most valuable in this connection, clearly showing that the prejudicial effect of even considerable quantities of inert constituents, in the shape of nitrogen, had been vastly exaggerated. On the other hand, it was shown that the presence of carbon dioxide in any undue quantity exercised decidedly prejudicial effects. The decision of the Committee dealing with this subject is of immense importance to us in the economical development of our processes of manufacture; and I venture to suggest that this fact weighed much with the Committee in their decision, which must not be taken in any way as indicating that "inerts" in any but the smallest possible proportions are to be countenanced. Any other reading of the Committee's decision would, in my opinion, be most undesirable. I consider the effect of both reports will be to assist considerably the gas industry in its endeavours to serve the public advantage.

Apart from our clear duty to the community to supply gas at the lowest possible price per unit, we must not forget that we have a powerful rival in electricity, the cheapening of the supply of which, manufactured in the huge superstations to be built, is one of the panaceas put forward as a remedy for existing unemployment, and as a gauge of future prosperity. Whether this belief be well-founded or no, time alone will show, but undoubtedly electricity is looked upon with a favourable eye by many in authority who will use every means to procure State aid for the schemes they favour; and the struggle will be hard to maintain ourselves in the position we have hitherto held, but which I am confident we shall continue to hold, as the most economical users of that precious asset of our country—coal—and as purveyors to the public of the means of light and heat, as well as to a great extent of power, at prices that compare favourably with those of our competitors.

Despite the low thermal efficiency of its production, and the losses incidental to its distribution, the mechanical advantage belonging to electricity, in the facility of its subdistribution on the premises of a consumer, is obviously a factor making for its extended use where power needs to be distributed to a multiciplicity of points, instead of from a single common source. For purposes of traction, electricity has its own field. There is ample room for both gas and electricity in the particular spheres in which they tend most to the public advantage; and, as I indicated in my address, I am strongly of opinion that in the true interests of coal conservation, which is a paramount interest of the community, the well-known report of the Coal Conservation Committee needs reconsideration on the basis of ascertaining how far the gas undertakings of the country and the electrical undertakings can best assist one another in the production of cheap gas and cheap electricity, both of which are necessities to general comfort and well-being, without the waste of the bye-products of coal, which in the production of electrical power at the present time is the rule rather than the exception.

The Coal Strike.

Reference to the desirability of cheapening the cost of gas naturally leads our minds to obstacles that have to be overcome. The latest, and for the time one of the most serious is in the minds of us all, meeting at this late season of the year—namely, the recent coal dispute, of which this deferred meeting is one of the least of its evil consequences. It is difficult to refer in moderate language to this national calamity (for it is nothing less) in the disturbance of industry, and the hardships and impoverishment it has imposed upon all sections of the community. To the gas industry, it is the culminating point of the adversity by which we have been beset in recent years. The total extraordinary expenditure forced upon our industry by this dispute cannot be less than £3,000,000, and is more likely to reach £4,000,000, which, piled on inflated costs of manufacture and restricted dividends, is a most serious blow to its prosperity.

I cannot but feel what appears to me to be justifiable pride in the manner the obligations of the industry to its consumers were met during this trying period. In most cases a full service of gas, of statutory quality, was continued throughout the whole period of the dispute; and in those cases where a restricted service became necessary, the pressure periods were so arranged that a minimum of inconvenience was experienced by the consumers.

It was no light task to "carry on." The quality of the bulk of foreign coal that had to be imported was poor in the extreme, while timber and even seaweed were pressed into the service for the manufacture of gas. In the case of my own Company, and doubtless in that of many other undertakings, carburetted water gas was of inestimable service in keeping-up the supply, without the corresponding necessity, in the absence of carburation, of lowering the calorific value of the gas supplied.

Attitude of Gas-Workers.

I am glad to take this opportunity of testifying to the manner in which our gas-workers carried on during what must have been a very trying period to them, with the usual routine of work. It was naturally repugnant to a large number of them to be carbonizing coal obtained from outside the country during the stoppage of mining here. But common sense and the sense of their duty to the community in keeping its members supplied with the means of light and heat prevailed; and it is to the credit of the gas-workers

that they continued without intermission in the conduct of their duties which, at all times important, were in the temporary absence of supplies of solid fuel at that time doubly so. I cannot but realize that so far as I was personally in touch with the gas-workers at the time, the influence of co-partnership in the good feeling existing between employees and the representatives of employers, had much to do with the unbroken continuance of operation.

CO-PARTNERSHIP.

Co-partnership may not be the ultimate means of ensuring that feeling of good fellowship which goes so far in permitting the friendly discussion of possible differences, and the examination of all ways of avoiding a dispute, rather than proceeding immediately to a cessation of work and sub-equent arrangement that after all has to be come to by conference, if friendly relations are to hold when work is resumed. Up to the present, however, co-partnership holds the field; and it is regrettable that it is not more widely adopted in other industries than our own. All the portents of the time point to the certainty that, far from leading that "fuller life" of which we have recently heard so much, we are committed to a period of severe international industrial struggle, in which the closest possible co-operation is to be observed between all classes of industry in this country if we are not all to go down together. We in the gas industry are able to demonstrate the very considerable success we have achieved in this direction; and although I am not as a rule particularly enamoured of advertisement, I am of opinion that for the good of the industrial community and the community generally, we should not in this case "hide our light under a bushel," but make widely known the benefits we have derived from co-partnership, in the belief that the more widely adopted is its principle and practice, the nearer we shall be to the elimination of the unfortunate industrial warfare which is so distressing and harmful a condition of our time.

In Praise of the President.

Mr. H. E. JONES (London): I am much indebted to those kind friends on the Council who have permitted me to come here and move that the best thanks of this Institution be given to the retiring President. It cost me a little effort. About two days ago, I was badly broken down, with a broken spring of a motor, and so was Dr. Carpenter, in the depths of the war country in France. We rather had cold water down our backs, fearing we might no be able to meet your President, and do him the honour he deserves. Many of you could discharge this duty better than I can, but none of you with more heart. Your President and I have soldiered together; for really it has been a continual warfare, even before the great war, and before the disturbances in the coal mines. As to the latter, I have an opinion of my own—that we really should have gone down into the mines, and got the coal ourselves. I have, indeed, had a life-long acquaintance with Mr. Goulden. I remember his going to Beckton as quite a young fellow; and I have carefully watched his career, which has been one of enormous responsibility. Just figure to yourselves. In the period of the coal strike, we had to look out for our 50,000, 60,000, or 100,000 or 200,000 tons; while he had to look for 2,000,000 tons of coal. That is what he has been bearing through all these years; and throughout all these years he has always been loyal and devoted, gaining an unrivalled experience, and giving the benefit of it to his professional *confrères* freely—always accessible, modest, and unpretending. Our President's name will go down in the future as that of one of the worthies of the gas profession, without taint of any sort; for I have heard of nothing that can mar our devotion to him as a sterling, righteous character. [Applause.] What the industry did in the war will go down to history in terms which have been written indelibly by the late Lord Moulton, who knew better than anybody else; and think what a large portion of the production of those explosives fell upon our President. I think of the enormous undertaking that he was controlling and guiding, while he was helping to swell the output of "T.N.T." and the other terrible things we furnished for the war. It is a remarkable fact that we see all round us gentlemen connected with trade—steel and iron, and so forth—walking off with great fortunes and titles and distinctions from the Government; but none has come our way at all. Where is our President? Where is his dukedom, or whatever it should be? [Applause.] I have said at a meeting of shareholders that it does not pay to be patriotic. We did not bargain, and make a trouble of producing these war necessaries. Do you recollect our being called upon to keep ships afloat with gas oil, showing that our assistance was vital to the Navy of this country? That is another little matter. Well, at any rate, Mr. Goulden has the knowledge that he is thoroughly appreciated, as is shown by the large meeting that I congratulate him on assembling here to-day. You honour him, and give him thanks for his devoted service. I await to see another distinction added to him—a simpler and more direct one. The late Sir George Livesey—the author of profit-sharing (which our President has been so eloquently approving) and of other things taking away shackles and restrictions of an unwise Legislature—would have rejoiced to have heard, as I did partly, and read a great deal more, the splendid evidence that was given in plain unvarnished terms by Mr. Goulden before the recent Committees. When the common-sense position is put forward, as Mr. Goulden did, in such a simple and direct manner, it carries conviction; and we are indebted to him, I think, for the larger part of the decisions of these Committees, removing the shackles and trammels that unwise but well-meaning people were seeking to put upon us. Sir George Livesey was the pioneer of a practice which has been very much extended (and I always do what I can to extend it), of placing engineers upon the counsels of the undertakings which they administer. Never can you get such ripe knowledge or experience of the details of the business of a gas company as that of the engineer; and in the case of Mr. Goulden, I shall be very disappointed if he is not very soon elevated to a seat on the Board of the Company he has so long and so faithfully served. I am sure, in your name, you will agree to let me say that we are very deeply indebted to our President for his conspicuous service in these special matters through a time perhaps unrivalled in anxiety and trouble by the great strike. He has borne our flag all through this period; and we congratulate him, and hope that in his retirement he will have long life and years of happiness and health. I am able to tell you one little matter which may amuse you. It is a secret. You know I am rather fond of the saddle. Mr. Goulden has paid my county the compliment of coming to live in it; and I have seen him, very wisely, seeking some recreation in the green fields and pastures upon the back of a good horse. He is a sportsman, therefore, as well as a gentleman and a good scientific servant. I will ask Mr. Milne Watson kindly to second this motion.

Mr. D. MILNE WATSON: I rise with very great pleasure to second this vote of thanks to Mr. Goulden. I, like Mr. Jones, have known Mr. Goulden all my official life. I found him with the Gas Light and Coke Company when I went there, in a high position; and now he occupies the highest position in the Company. During all the years that I have known Mr. Goulden, I have found him, as Mr. Jones has said, a straightforward, honest, capable man, a man whose word is as good as his bond, and who has known, through all the difficult times through which we have passed, how to keep his head. I do not remember any occasion on which Mr. Goulden has really lost his head; and there have been many occasions of late years when it has required a very steady head not to be turned. Of Mr. Goulden's engineering ability I need not speak to-day. You all know his quality, you all know his views, you all know the great work he has done, not only for the Company with which he is connected, but for the industry at large; and I am very pleased indeed to be here this morning to testify my appreciation of his work, and to second this vote of thanks to him. Whether in his public work or private work, he has always thought of the industry first and foremost, and his personal convenience second. He is absolutely heart and soul with modern movements; and we owe a very great debt of gratitude to him for his help in the satisfactory conclusions that have been come to by the inquiries which have been recently held on carbon monoxide and inerts. I will not take up more of your time to-day, but will just state what a great pleasure it is for me to second this hearty vote of thanks to Mr. Goulden for his very illuminating address.

The vote of thanks was carried with acclamation.

The PRESIDENT: I thank you from the bottom of my heart for the manner in which you have received this proposition. It is very difficult indeed for me to speak with any equanimity in respect of the very very kind terms in which Mr. Jones proposed the vote of thanks, and in which Mr. Milne Watson seconded it. It is very gratifying to me to hear such kind things said by Mr. Jones. I have known him for even more years than I have Mr. Watson. We have been very closely in touch over the whole of my career with regard to gas matters in the Metropolis, and that we have succeeded I think is patent to all. We have never had any but the most friendly relations, our works have been open to one another, and to our staffs, in each case; and it is only by this friendly co-operation that we are able to achieve the success that I am sure is in the power of industry as a whole. I do not complain at all of being left out of the particular honour that Mr. Jones indicated was fitting for me. If our Premier has the same opinion of dukes that he expressed some considerable time ago, I take it he thought the matter over, and, out of consideration for me, spared me the honour of making me one of them. [Laughter and applause.] Mr. Jones refers to events other than professional; and it is evident that he looks back occasionally. If he has seen me in the hunting field, I am quite sure it was behind him, because, knowing his thrusting abilities and propensities, I would never dare to ride in front of him. I thank Mr. Watson, too, from the bottom of my heart. I have done my duty as a loyal officer of the Gas Light and Coke Company; and if it is recognized that I have done this, it is quite sufficient reward for me. We have all got our places; and the close way in which we have to work in a very large undertaking such as the Gas Light and Coke Company is, keeps a good many of its officers from attending to outside affairs connected with the industry that otherwise it would be their pleasure to do. For this reason, it is only of late years that I have had the pleasure of meeting you gentlemen in the way I have.

Presentation to Mr. Samuel Glover.

The PRESIDENT: I have a particular pleasure in performing a task which is no task at all, and that is to present to Mr. Glover a testimonial of our appreciation of him and his many good qualities for the long years during which he has served the St. Helens gas undertaking. I am particularly glad to have the opportunity of doing this honour to Mr. Glover. We all esteem him; and, as you know, he is now retiring from the service of the St. Helens gas undertaking, after the long period of fifty years of what is recognized by all as fifty years of devoted, loyal, and useful service. [Applause.] He has not only served the St. Helens gas undertaking, but the industry as a whole, and especially in connection with the particular form of retort, the vertical retort, with which his name is associated; and if his name in regard to matters generally were only connected with that, I am sure we should recognize a very great debt of gratitude to Mr. Glover. Then we come to the Institution; and, in common with the Council, I can testify how much we owe to Mr. Glover. He has great experience, he has a very well-balanced mind, and, as we know, is a very independent sort of person, who certainly does not object to speaking his mind when the necessity arises for it; and he has always been of very great assistance to us on the Council. May I take this opportunity of saying how much I value his services in assisting and guiding me during my term of office? But I should like to mention one particular debt that I think we owe to Mr. Glover—and that is for the unselfish way in which he deals with these matters, and particularly for the unselfish manner in which he stood down, I think it was four years ago, when his term of presidency had arrived, in order to enable Lord Moulton (whose decease we so much regret) to occupy this chair. Had it not been for Mr. Glover's unselfishness on that occasion in consenting to stand down, as events have turned out, unfortunately, it is very doubtful whether we should have had the honour of recording the name of so distinguished a man on our roll of Presidents; and we should have missed the most delightful address which we had the pleasure of listening to on the occasion of our annual gathering during his term of office. Then Mr. Glover, during the war, offered his services unreservedly to the State; and they were taken advantage of. He served in what was certainly a most thankless office—that of the Coal Controller; and I daresay it was due to him, in large measure, that we were not very much more seriously inconvenienced from that centre of control than we were. Mr. Glover, it gives me the very greatest pleasure to present you with this address; and, if I may, gentlemen, I will read it before handing it on to him.

INSTITUTION OF GAS ENGINEERS.

FOUNDED ABOUT 1863 AS THE BRITISH ASSOCIATION OF GAS MANAGERS.

Incorporated 1902.

At a Meeting of the Council held at No. 30, Grosvenor Gardens, Westminster, on the 29th June, 1921,

IT WAS RESOLVED

that the sincere congratulations of the Institution of Gas Engineers be tendered to

SAMUEL GLOVER, ESQ., M.INST.C.E., F.R.M.S.,

President of the Institution for the year 1918-19, on his attainment on the 1st May, 1921, of fifty years continuous service in the Gas Department of the Corporation of St. Helens and in the St. Helens Gas Company as pupil, assistant, deputy engineer, and chief.

The Council desire to record their appreciation of Mr. Glover's unceasing efforts on behalf of the gas industry generally, especially in the important detail of carbonization. The services he rendered to various Government departments during the Great War and also since the declaration of the Armistice on the 11th November, 1918, will always be remembered with satisfaction.

The Council express the hope that in his retirement from the position of Engineer and General Manager at St. Helens, Mr. Glover may long be blessed with good health, and retain the close friendship of his colleagues, who take this opportunity of expressing their sense of his genial characteristics and professional attainments.

Given under the seal of the Institution at Westminster on the 29th day of June, 1921.

As witness our hands:

THOMAS GOULDEN, *President.*
THOMAS HARDIE, *Senior Vice-President*
JAMES D. SMITH, *Junior Vice President.*
WALTER T. DUNN, *Secretary.*

W. E. PRICE, *Hon. Secretary.*

The presentation of the testimonial was made amid loud applause.

Mr. SAMUEL GLOVER (who was received with rousing cheers): Mr. President, ladies, and gentlemen, I stand in a position of some difficulty this morning, inasmuch as, notwithstanding I have known that this presentation was about to be made, I have not been able to find words—it is literally true—I have not been able to satisfy my own mind that I could find adequate words to express to the Council, in the first instance, my thanks for thinking of this presentation. I cannot claim this morning that I am taken by surprise, and therefore cannot find words to voice my feelings; but it is after careful consideration, after being deeply impressed more than once by the fact that this presentation was going to be made, that I still fail to find words to thoroughly express my feelings in the matter. Having tried to serve in whatever capacity I was called to the Institution of Gas Engineers—for which I have, as many of you know, a very deep respect, and regard which amounts to a certain quality of love that you can have for your fellow men and their institutions—you can quite understand how impressed I was when I first discovered that it was intended by the Council to propose to you the expression of anything like the feeling shown in the document, so beautifully worded, that has been presented to me this morning. I was very much surprised indeed. As any human ought to be, I am not going to try to hide from you the fact that I was deeply gratified, and am very deeply gratified, especially now that the Council, after deliberation and consideration, and some

venturesomeness (for it is quite an unusual procedure on the part of the Council of the Institution of Gas Engineers) have actually made the presentation. But now that you have so heartily confirmed their action, what shall I say? I can only try to express to you in some degree my feelings; and it will be only in a measure that I can hope to do so. Now that you have confirmed the action of the Council, I do most heartily express to you my thanks for the honour you have done me. What man would not be touched by such a presentation? Nobody who, like me, loves his fellow men; nobody who, like me, has striven to serve them—and it is just because I have striven to do my duty during my fifty years' service at St. Helens that has been made the occasion for expressing these other feelings towards me. Of course, fifty years' service, long as it is, may not of itself mean very much. A man can become a very decided fossil by staying for fifty years in the same place; but the fact that St. Helens is my native town, and that I have been working under the supervision of the leading men there during the greater part of the fifty years, shows that I have been labouring among those who have had their opportunity of knowing me. They have given me every opportunity of serving the industry that I have devoted myself to in any capacity that I was called to; and I commend this treatment of engineers to all who are authorities in gas matters—that they should allow their engineer to have full scope of every opportunity he has of doing duties in other quarters, and of serving the industry in any capacity that he may be called upon to serve it. I thank you very much for the hearty way in which you have confirmed the action of the Council, who have had many opportunities of observing my conduct during the last ten years.

The late Mr. Hastings and Lord Moulton.

The President: The next business is the presentation of the report; but before I go on to that I would like to make a very brief reference to the fact that to the names of deceased members published there, we now have to add that of Mr. Charles W. Hastings, of the "Gas Engineers' Magazine." I am sure you will all share with the Council and myself the regret at the decease of Mr. Hastings. He was a personal friend of mine. I have known him throughout the whole of my professional life; and during all that time his many good qualities had always endeared him to me. He was a most genial and friendly man, and one whom everyone who came in contact with could really love and esteem. I would also just mention the fact that the name of Lord Moulton is at the head of the list of deceased members, and I am sure you will all join in one universal feeling of regret at the loss of Lord Moulton as a member of the Institution, and as a member of the scientific community in which we live. He conferred a great honour upon us. It was a recognition by Lord Moulton of what he considered, and rightly considered, the industry's services to the State, in assisting him as Director-General of the Explosives Department. We gave him very loyal service at a time—a very critical time—in the history of the State, when what the gas industry could do, and could alone do quickly, was absolutely necessary for the salvation of the State. We were short of explosives, and did not know which way to go for them. Lord Moulton came forward, and infused his enthusiasm into the minds of us all; and the gas industry rose, as everyone knowing the gas industry knew it would rise, to the country's call, and did its best in saving the situation. Lord Moulton always made very generous recognition of this; and I have not the slightest doubt that it was in consequence of it that, at his advanced age, he came forward and consented to serve a term of office as President. It was a great privilege, a great honour, and a great advantage to us to have his guidance during that time. I think his address, if I may say so, was a beautiful address in its feeling, and in the language in which he expressed his opinions and gave voice to his feelings. I will ask you to rise as a small testimony of our loss.

The meeting silently rose in memory of the late Lord Moulton.

The Annual Report.

[See "Journal" for May 25, p. 431.]

The President: The annual report of the Council has been circulated; and I hope its contents have been thoroughly digested by everyone here. I therefore propose that it be adopted.

Mr. Thomas Hardie seconded the motion, which was unanimously adopted.

Fifth Report of the Gas Investigation Committee.

[See p. 197.]

The President: The next item is the discussion on the Fifth Report of the Gas Investigation Committee on Recording Gas Calorimeters. This is to be presented by Prof. Cobb. It has already been published; and, as I said in my opening remarks, I hope that the fact that the contents are thoroughly known to everyone will produce a more full discussion than would possibly otherwise have been the case. While I am speaking about calorimeters, may I draw your attention to the fact that at the County of London Testing Station at Carlisle Square there are calorimeters set up which are being tried by the Gas Referees now with the object of ascertaining whether they are fit instruments to be used for the continuous recording of gas under the terms of the Gas Regulation Act. Besides these three calorimeters, there is another calorimeter to which I would particularly draw your attention, for works use. It is a very simple calorimeter; and it appears to give excellent approximate results. It is the Brady calorimeter.

Sixth Report of the Gas Investigation Committee.

The Sixth Report of the Gas Investigation Committee (on Blue Water Gas) was then presented by Prof. Cobb and Dr. A. Parker [see p. 202] and discussed.

Report of the Refractory Materials Committee.

At the commencement of the afternoon session on Tuesday, Mr. Thomas Hardie temporarily took the chair, and called upon Mr. A. E. Broadberry to present the report of the Refractory Materials Research Committee—see p. 204.

Steaming in Vertical Gas-Retorts.

The President: The next item is the discussion on a paper by Sir George Beilby, F.R.S., Director of the Fuel Research Board, on "Steaming in Vertical Gas-Retorts." I do not think Sir George Beilby is here; but Dr. Lander, of the Fuel Research Station, will introduce the paper—see p. 206.

Carbonization in Horizontal Retorts.

Mr. G. M. Gill (Chief Engineer to the South Metropolitan Gas Company) then presented his paper, which was illustrated by lantern slides, on the subject of "Carbonization in Horizontal Retorts." The full text of the paper is reproduced on p. 212, with a report of the discussion, which had to be adjourned until the following day.

This concluded Tuesday's sessions.

Meeting of the Benevolent Fund.

The first business on the Wednesday morning was the annual general meeting of the Benevolent Fund—the President in the chair.

The President: In order to save time, I shall be glad if someone will propose that the minutes of the last meeting be taken as read.

Mr. H. Kendrick (Stretford) proposed, Mr. P. S. Hoyte (Plymouth) seconded, and it was agreed to.

The President: The report, I believe, is already in your hands; but I should like to draw your attention to two or three features of it. You will be glad to see that, in spite of increasing the allowance made to applicants for relief from the fund, we have, including donations and subscriptions, a relatively handsome surplus over disbursements. The income of the fund for the year ended Dec. 31 amounted

to £460 9s. 3d., of which rather more than one-half, or £253 8s., was derived from annual subscriptions. As a rule, we like to consider donations as contributions to capital; and we have been able to do so on this occasion, in spite, as I said, of increasing the amount of money given in several cases to recipients from the fund. After deducting the amount received for donations, there was an excess of income over expenditure for the year of £72 16s. 11d. It is not a large margin, and I would draw the attention of members to the fact that our investments, which stand at £3023 15s. 10d., have not been written down. They stand at cost price; and we think it wise, before we make up the current year's accounts, to write them down. This will probably have the effect of reducing the value of our investments to about £2000, thus considerably curtailing reserves that we may have to draw upon at any time. The total membership of the Institution now is rather more than 900; but the number of our subscribers is only 363. This is well below 50 p.ct. of our membership; and I should like to see the proportion increased as far as possible. The times are bad; and it is quite clear that they are not going to be better for some considerable period. Though we have some capital in our locker, we do not want to draw upon it; and we never know when large calls may be made upon us. Not subscribing is one of the sins of omission, rather than of commission. We are apt to let things go. We cannot, however, put subscriptions to a better purpose than that of relieving the necessities of those our colleagues have left behind them. Gas-works range from the smallest size, which may be run by one man, to the very big ones such as I am connected with; and it is the smaller brethren, who have not a pensions fund on which to draw when they give up work, whom we want to assist. I hope therefore that, when we come to consider the report this time next year, we shall find the subscriptions to the fund considerably increased. I do not think I need comment further on the report or the accounts; but I should like to read you a letter which it is very gratifying to the Committee to receive. It is from the City of Chichester Gas Company, dated Sept. 30, and is addressed to the Secretary of the Benevolent Fund. The letter, which is signed by Mr. Victor V. Vick (Secretary), is in the following terms:

> **The sum of £6 5s. recently came into my directors' hands from an outside source for disposal as seemed best to them; and I have pleasure in saying it was the decision of the Board, at its meeting on Tuesday last, that the amount should be divided between the Royal West Sussex Hospital and the Benevolent Fund of the Gas Institution of Great Britain.**

We are very pleased indeed to have this letter. Though the amount is not large, what we are glad about is the spirit shown. I know you will feel as pleased as the Committee at receiving this communication. [Applause.] We are very much indebted to the City of Chichester Gas Company for their action. I beg to move the adoption of the report.

Mr. J. FERGUSON BELL (Derby): I have pleasure in seconding the motion, and feel that, after the President's appeal, it requires no words of mine to commend the Benevolent Fund to every member of the Institution. It is very unfortunate that we have not more than 363 members subscribing. Several cases have come under my notice in which the assistance of the Benevolent Fund has made all the difference between absolute starvation and people being able to educate their children. The fund is used to make provision for those who are not able to help themselves. We had a case in the Midlands recently where a young man was taken away before he could make any provision for his wife and family; and therefore we are applying to the fund for help. In another instance a young man from Yorkshire was taken away, and his wife left totally unprovided for. But by means of the fund she was able to educate her sons; and now one of them holds a responsible position in the gas industry. I could enumerate other instances in which the fund has been the salvation of a family. I would therefore ask those present to mention the matter to their friends, so as to see that everyone who belongs to the Institution makes a point of subscribing to the fund. We want a lot of small subscriptions, which, when they are totalled-up, make a fair sum. The fund is doing most excellent work.

Mr. D. IRVING (Bristol): I would like to express my sympathy with this fund; but I think the Committee will do well to remember that there are a great number of our members who can ill-afford at this time to subscribe to such a fund. The Committee are to be congratulated upon the amount of subscriptions they receive; and they must not expect some of our members who cannot spare the money to become subscribers. Some whom I know are really in need of assistance themselves, rather than in a position to contribute to the relief of others.

Mr. JOHN BALLANTYNE (Hamilton): If I remember aright, the suggestion was made last year or the year before that the Council should consider the advisability of raising funds on the same lines as they do in the North British Association, where every member, no matter how small his works may be, has to contribute a certain amount towards the Benevolent Fund of the Association. If this system could be introduced into the Institution of Gas Engineers, it would overcome all difficulty. Perhaps there is something in the constitution which might prohibit such a thing being done; but I thought the matter would be worth considering, if it has not been already. I am quite certain there is not a single member of the Institution who would be unable to pay the small sum that would be involved.

The PRESIDENT: The suggestion we have just received shall have every consideration; but I must say my own inclination is not to take a course like that unless we find that our income is much nearer to our expenditure than is the case at the present moment. It is infinitely preferable, if we can see our way to give relief in all the cases that we judge worthy of assistance, to rely entirely upon the voluntary principle by which we get our subscriptions now. I would sooner myself continue the custom we have followed for so many years, of receiving subscriptions from those members who may care to send them in. I quite endorse Mr. Bell's remarks. What we want is to increase the number of subscribers. We should like to feel that as large a proportion as possible of the members of the Institution are subscribers to the fund. However, the suggestion shall have every consideration; and we thank the maker of it.

The motion that the report of the Committee of Management of the Benevolent Fund be received and adopted was unanimously carried; and the proceedings closed.

The discussion on Mr. Gill's paper was then taken.

Liberation of Nitrogen from Coal and Coke as Ammonia.

The PRESIDENT: I will now ask Prof. Cobb to introduce the report of the Institution Gas Research Fellowship, on the "Liberation of Nitrogen from Coal and Coke as Ammonia," by himself and Dr. A. C. Monkhouse.

Prof. COBB, in doing so, prefaced his remarks by pointing out that Mr. Monkhouse held the Research Fellowship last year, and is the first graduate of the University of Leeds to take the newly-instituted degree of Doctor of Philosophy. He has, added Prof. Cobb, collaborated with me on a subject which has occupied my attention repeatedly in the past year.

Dr. MONKHOUSE then gave a *résumé* of the report, which is printed in full on p. 234.

Tar Distillation and Sulphate of Ammonia Manufacture.

The PRESIDENT: We now have to consider the paper which has been prepared by the Society of British Gas Industries, on "Tar Distillation and Sulphate of Ammonia Manufacture," which will be presented by Alderman Fred. J. West, Past-Chairman of the Council of the Society. An abstract of the paper will be found on p. 231.

Mr. FRED. J. West, in presenting the paper, said: I am not in any way associated with the compilation of the paper, except to act as scrutineer on behalf of the Society, to see that it conforms to the conditions. Fortunately, also, I am not expected to answer the discussion. The compilers are

here, and will deal with any points raised. The conditions under which the paper has been compiled are those which applied to the paper last year on carbonization methods; and these conditions preclude any reference to tests, patents, or claims of superiority over other apparatus. While the conditions may to some extent have limited the scope of the paper, it is hardly necessary to elaborate why such stipulations are essential in a joint paper of this nature.

Report of the International Commission on Illumination Conference.

The PRESIDENT: We will now take Mr. Robert Watson's report of the International Commission on Illumination Conference at Paris, to which he went as representative of the Institution. [For the text of the report, see p. 226.]

Mr. ROBERT WATSON (Doncaster): I do not intend to occupy much time, because I know time is valuable for other important subjects. The report which I have the honour of presenting to you to-day is intended, not so much to raise points for debate, as to give you a general idea of the proceedings and the scope of the work undertaken by the International Commission on Illumination, which met in Paris early in July. There has been a lapse of some eight years since the last meeting of the Commission in 1913; and it can be understood that many who have had occasion to follow progress in illumination have somewhat lost touch with the subject. Further than this, we have all been occupied with matters of great and vital concern during the war, and its aftermath; and we have been thinking also of calorific power rather than candle power. So that illumination matters have to a very great extent dropped into the background. At the same time, though incandescent lighting, of which we have, fortunately, a considerable share to deal with in this country, may depend upon heat units, so far as the public is concerned, incandescent lighting is only appraised by its candle-power value. The lighting loads are still of great consequence to the gas industry, though we may be concentrating our work on heating and cooking loads. I suggest that, however this may be, it is very important to the gas industry that we should keep in touch with all illumination questions, as the International Commission on Illumination has for its scope the investigation of illumination generally, and research work in its connection; and the Institution as a whole would be well advised to keep closely connected with, and in touch with, the work of this Commission.

Report of the Life of Gas-Meters Committee.

The PRESIDENT: The next business is the presentation of the report of the Life of Gas-Meters Committee.

This was done by Mr. B. R. PARKINSON. [See p. 224.]

The PRESIDENT: Before we take the next business, I should like to read a telegram that has just been received from Paris:

[TRANSLATION.]

To the President of the Institution of Gas Engineers, Grosvenor Gardens, London, S.W.

The President and members of the Committee of the Société Technique de l'Industrie du Gaz en France send to their British colleagues assembled in London best wishes for the success of their meeting, and the renewal of the expression of their regrets at not being able to be actually present among them, and of their sympathetic regard.

R. ELLISSEN, President.

I am sure it will be your wish that we should suitably reply to this kind message. ["Hear, hear."]

The External Corrosion of Services and Mains.

The PRESIDENT: The last item on our programme is a paper by Mr. J. G. Taplay on the "External Corrosion of Services and Mains." The paper will be presented by Mr. Herber who has been closely associated with Mr. Taplay on the subject of the extraction of cyanogen. [See p. 210.]

Place of Next Meeting.

The PRESIDENT: The next business is to decide on the place of meeting for next year. Apart from any other advantages, I think the fact that we are going to receive the return visit of our colleagues from France, accompanied by their ladies, will practically tie us down to London. There is no other place in which we can receive a foreign delegation so favourably as we can in London. I should be glad to have the opinion of the meeting on the matter—bearing in mind the fact of this contemplated visit of our French colleagues.

Mr. SAMUEL GLOVER: I do not think there need be any hesitation about suggesting that London should be the place of meeting next year—especially in view of the circumstances that we shall, as this year, have a London engineer for President, and that we have to look forward to greeting our French *confrères* in the gas industry at that meeting. Perhaps Mr. Hardie will kindly give us his views on the suggestion that the meeting place should be London. And may I express the hope that the meeting will be organized in time to secure a better place than this for hearing? I know the reason why we are meeting here; but I wish to encourage the Council to persevere with their arrangements, and secure a good meeting place on the next occasion. I beg to propose that we meet in London.

The PRESIDENT: Will Mr. Hardie, the President-Elect, say a word on the subject?

Mr. THOMAS HARDIE (London), who was very cordially greeted, said: I would like first of all to take this opportunity of thanking you very much indeed for the honour you have done me in electing me your President. I have not been on the Council for the last five or six years without learning something of the responsibilities of this office. Therefore it is not altogether without fear that I have undertaken it. But I shall do my best; and I trust, with the generous support which is always given to the President by the members of the Council, that I shall carry out the duties to your satisfaction. With regard to the meeting next year, I am perfectly in agreement with both the President and Mr. Glover that it should be in London. The French engineers were expecting to visit us in London this year; and we have told them we shall be very pleased to see them next year. We have had a communication from them saying they hope to be able to arrange to come over in June. Therefore, I think it will be well to meet in London. I am very pleased to second Mr. Glover's motion.

The proposition that the next meeting should take place in London was then unanimously agreed to.

Thanks to the President.

Mr. J. FERGUSON BELL (Derby): The honour that has been conferred upon me is to propose that the best thanks of the meeting be accorded to our worthy President for his occupancy of the chair during the past year. I am quite sure that this resolution requires few words from me to commend it to the members of the Institution. Mr. Goulden did not seek the office. He is a gentleman who does not like to be in the limelight; but the members knew that in him they would have the right man in the right place. ["Hear, hear."] Therefore they unanimously elected him President. He has been President during a unique time, for his period, instead of being twelve months, has extended over fifteen months; and they have been very trying months. During that time, the gas industry has passed through a very difficult period; and in Mr. Goulden we have had a sagacious head. Mr. Goulden, as the Chief Engineer of the largest and most important gas company in the world, must

have many calls upon him; but over the whole of these fifteen months he has always been ready to give the Council and members of the Institution the full benefit of his ripe experience. We older members of the Institution remember that we have had celebrated men as Presidents; but none, I think, has excelled Mr. Goulden in the filling of the chair. I was sorry not to be able to be present yesterday, when I believe Mr. Goulden set the tone of the meeting by his splendid address. Also, I am told what a treat I lost last night by not being able to attend the reception. Mr. Goulden, as I said before, has great calls upon his time; but he has always been ready to guide the Institution. We all know that such an Institution as this depends to a large extent upon the President who controls the policy; and in Mr. Goulden we have a gentleman who, through his unique experience as an engineer, has been able to control that policy to the benefit of the members. We have been through a dark time; but I believe the gas industry is now going to reap the fruits of our sowing during this troublous period; and we thank those in office who have been able to pilot us through. I only voice the opinion of the members when I say that in Mr. Goulden we have an admirable President; and it is under a deep feeling of gratitude that we give him our hearty thanks. I feel sure he will look back upon his term of office with pleasure and satisfaction. The members are all well satisfied with the meeting, which had unfortunately to be postponed. This autumn meeting has proved to be one of the best. In fact, some members have suggested that we might in future have two meetings—one in June, and another in the autumn—as this has been so successful.

Mr. D. IRVING (Bristol): I have great pleasure in seconding this resolution. In our President we have a man of distinguished ability, and much experience; and this has enabled him to render great service to the Institution—and not only to the Institution, but to the gas industry generally. I am sure that we all very much appreciate what he has done, and that you will most heartily and sincerely support the resolution. He has had a very exceptional year of office.

The resolution having been carried with acclamation,

The PRESIDENT said: It is very difficult for me adequately to express what I feel. I should like to say in acknowledgment of the very kind, but far too flattering, remarks in which this proposition has been put and seconded, that it cannot but be a matter of the greatest pride to any member of our profession to hold this office; and I wish to express my deep gratitude to the members generally and to the Council for affording me the privilege of occupying the chair. We, as gas engineers, follow, I think, a most fascinating profession. In fact, I am of opinion that we follow one of the ideals of the engineer, in rendering serviceable to the community that great resource of nature—coal. Unfortunately, in this country our seams are getting deeper, and the coal is costing more to mine; and therefore it is incumbent upon us to husband our resources to the utmost extent. Now, in providing means of light, heat, and power, as we do by the manufacture of gas, we claim, and we know that we rightly claim, to deal with this great asset of the country, coal, in the most economical manner; and if we do this, and at the same time provide the community with what has come to be a necessity for their comfort and well-being, we can very well feel satisfied in belonging to a profession in which these objects are carried out. The extension of our business, and the growing use of gas, besides conserving the coal resources of the country, contribute materially to its health. We heard recently the delightful lectures of Dr. Saleeby on the influence that light and the free access of sunshine to the streets of our cities has in preserving the good health of the people. And apart from the bearing which the use of gas has, in the abolition of smoke, on the health of the community, there is the freedom from drudgery which it is able to bring to the household. I think that in this respect we may particularly pride ourselves on being the very good friends of the working classes. When the use of gas is able to assist cleanliness and reduce labour in a house, it must be of immense benefit to the occupants. Therefore I am proud to be a gas engineer, and additionally proud to be President of the Institution of Gas Engineers. It has been no task at all to me during my term of office. In fact, the period, in its relations to the Institution, has been one of continuous pleasure. I know the members of the Council better than I did at the commencement of my year of office; and I have, if possible, even more affection for them than I had before. One and all have given me the greatest possible assistance, thus rendering my office practically a sinecure. We have had difficult times in the gas industry of late years; but it seems now as though we were starting a new era. Indeed, I hope so. The times we have passed through have taught us a very great deal, and have rendered possible the introduction of reforms that would otherwise have taken years to accomplish. That is one good thing which has arisen for us out of the war. Had it not been for the power of the authorities to make the Orders they did with regard to calorific power during the war, you can imagine what a struggle it would have been, in the absence of experience with reduced calorific value, if we had had to fight the matter out now. But at any rate, as I have said, we seem to be starting on a new era at last; and I am glad to know my friend Mr. Hardie will be succeeding me, and so will be in the chair during the commencement of this new period. I should not like to sit down without expressing my thanks to Mr. Dunn, our very able and very energetic Secretary, for the work that he has done in the past year. He has been most helpful to me; and it is difficult for me to tell you how much I owe to him and his experience in dealing with matters. With regard to the very pleasant evening that we had yesterday, it was no trouble to me, because Mr. Dunn arranged the whole thing, and, as I am sure we wish to acknowledge, did it in a most admirable manner. Again I thank you.

Mr. Thomas Settle Honoured.

The PRESIDENT: I have now to deal with the election of honorary members. The Council have given very considerable thought to a proposition that Mr. Thomas Settle should be elected an honorary member; and when you recollect the vast improvements in methods of carbonization which are likely to accrue from the more general adoption of the vertical retort, I feel sure there will be no divided voice in so electing Mr. Settle. [Applause.] It is a good many years ago that Mr. Settle first put up and worked a vertical retort at Exeter. He was undoubtedly one of the pioneers; and I think it was his work at Exeter, which was followed by others, that has provided us with the present development of vertical retorts. I have much pleasure, therefore, in proposing the election of Mr. Thomas Settle as one of our honorary members. His election has been submitted to the Council, and, as I say, they gave very careful consideration to the matter, and were unanimous in their recommendation that he should be elected. I trust you will heartily confirm this proposition, which I will ask Mr. Hardie to second.

Mr. HARDIE: I am very pleased to second the proposal that Mr. Thomas Settle should be made an honorary member of the Institution, and have no doubt it is the unanimous wish of the members, as it was the unanimous wish of the Council, that this honour should be bestowed upon him. I can remember going to Exeter many years ago to see the first vertical retort installation there. At that time it was thought that they were on right lines; and great results were expected from it. Unfortunately, however, there were little faults in the mechanical means of extraction, which prevented the retort from becoming in the end the success it deserved to be. In the way proposed, we can give to Mr. Settle a little of the honour which he has undoubtedly earned.

After the proposition had been heartily passed,

The PRESIDENT said: Mr. Settle, I am glad to see, is here, and he might possibly like to say a few words.

Mr. THOMAS SETTLE: Mr. President, members of the Council and of the Institution, I am very proud of this honour which you have conferred upon me to-day. My mind goes back now to this very month twenty years ago.

We have gone on from those results to something better. Of course, 13,250 c.ft. of 520 B.Th.U. net gas was a startling figure at that time; but now you have got your passport to make just what you like. I thank you very much.

Kindred Associations Abroad.

The PRESIDENT: It is customary to elect as honorary members the presidents of certain foreign gas associations with which we have such friendly relations; and I therefore beg to move that we so elect the Presidents of the French Gas Association, the American Gas Association, and the Italian Gas Association.

This was heartily agreed to.

An Omnibus Vote.

Mr. HUBERT POOLEY (Leicester): A very pleasant duty falls to my lot. The ground has been so covered in respect of the difficulties of the past year, that I do not want to lay too much stress upon this point at the moment. My duty is to propose a hearty vote of thanks to the Council, the Hon. Secretary, the Secretary, the Research Committees, the authors of papers, the Scrutineers, and the Auditors. It is a very omnibus resolution; but I do not think we should honour it any the less because it is so all-embracing. As to our Council, we have had evidence to-day, not only of the work done by them, but of the respect in which they are held. They have worked under great difficulties. The postponement of the meeting from June until now must have caused them the greatest anxiety. But they have their reward in the attendance that we see here.

Mr. W. E. VINSON (Gloucester): I rise with pleasure to second the vote of thanks which has been proposed by Mr. Pooley. We quite realize that the Council have had a considerable amount of work to do in the past year, on account of the strike and of the postponement of the meeting, which has meant practically speaking double labour for them. With regard to the Hon. Secretary, he is too well known to require much praise. We are all aware how excellently he has done his work. As to the Secretary, I was pleased to hear the President speak so well of him. I have known Mr. Dunn for many years, and have always experienced from him every courtesy, and have realized the amount of work and ability put by him into his duties. The Research Committees have given good evidence of what they have been doing during the year; and we have also had very interesting papers from the different authors, which will be a valuable addition to the proceedings of the Institution.

The PRESIDENT: You have heard the resolution. I wish particularly to emphasize what has been said by the proposer and seconder.

The proposition having been carried with applause,

Mr. JAMES PATERSON (Cheltenham) said: On behalf of the Council, I beg to tender to you our very sincere thanks for the kind vote you have just passed. The Council's work is, perhaps, not so much in the limelight as is often the case with bodies of this kind; but I can assure you the work on the Council of the Institution is of the most interesting, and at the same time engrossing, nature. It demands the utmost ability of each member; but I think all can see that the Council, individually and collectively, takes up its burdens and does its best. As you know, the competition nowadays for a seat on the Council is considerable; and I am sure that this is all to the good, in that the best representative men from each part of the country in turn come to take their place on the Council. I would just like to emphasize the fact that the work which the Council do in assisting in the conduct of the affairs of the Institution would be lost if it were not for the guidance and kindly leading which the President has always given. He is the pivot round which the Council centres. This year we have had a President who has led us as a leader should; and it is as much to him that thanks are due as to the Council itself.

Dr. A. PARKER: It gives me much pleasure to reply to this vote of thanks on behalf of those who have carried on the research work and have prepared the papers presented at this meeting. I am sure I am expressing the feeling of all of us when I say that we have really enjoyed doing what we have done, and we hope that we have done something at all events towards advancing the industry. In addition to the enjoyment we have thus had, we have been more than repaid by the attendance at the meetings, the great interest that has been shown, and the kind words said.

Mr. W. E. PRICE (Hampton Wick): As only a unit in this *multum in parvo* vote, I shall not take more than my proportion of time in replying to the very kind words that have fallen from the proposer and seconder of the vote, so far as they refer to me. I thank you very much for the way in which you have received my portion of the vote, and can only say that, so long as you will put up with me, I will do the same by you. It is now about eight years since I began to learn something of what was going on in the Institution; and it has been my endeavour to follow-up the policy adopted. We try to be consistent, and to do our best for you.

National Illumination Committee.

The PRESIDENT: Before we separate, there are just two points I would like to mention, one of which was an omission of mine that I wish to put right now. I have to inform the meeting that Mr. John Bond, who was one of our representatives on the National Illumination Committee of Great Britain, which is affiliated with the International Commission on Illumination, has resigned; and the Council have elected in his place Mr. J. G. Clark, who is one of our members, and is an expert on all matters dealing with the measurement of light. We cannot be better represented than by Mr. Clark; and I hope you agree with the action of the Council. [Agreed.]

An Offer by Sir Dugald Clerk.

The PRESIDENT: Then Sir Dugald Clerk, who we all know has at various times given a great deal of information with regard to the comparison of thermal efficiency in the manufacture and use of gas and electricity, has offered to assist us and pay the expenses of collating the papers and various facts that he has published at different times on these subjects in one brochure, which we shall print and publish on his behalf for distribution to our members. He made the offer a little while ago; and we felt that a book such as this would be of the greatest possible interest and information to our members. It is very necessary in these times to know all the figures of comparison with regard to the two methods of supplying light, heat, and power; and I am sure you will empower me to give to Sir Dugald Clerk the very grateful thanks of the Institution for his kind offer. For the purpose of lecturing, we have a large diagram which was one that Sir Dugald Clerk used in the discussion some time ago with the Institution of Electrical Engineers. It is, on application to Mr. Dunn, at the service of any members of the gas industry who may wish to give lectures on the subject.

Meter Connections.

The PRESIDENT: Mr. Livesey asked a question with regard to the connections of meters—whether they should not be made to the sizes of iron pipes. If Mr. Livesey or any other gentleman wishes for the connections of meters to be made suitable for iron pipes, the manufacturers, I believe, are quite ready to meet purchasers in this direction.

The PRESIDENT: We have unfortunately had to close somewhat prematurely some of the discussions. We had hoped that, by the publication of the reports, &c., which was rendered necessary by deferring the meeting, we should have had ample time at disposal for the full discussion of all papers and communications. Experience has shown, however, that the discussions in some instances were cut short. We have had an enormous amount of exceedingly interesting matter put before us; and we should welcome any further additions to the discussions in the nature of written communications. If members will communicate any views or criticisms in writing to Mr. Dunn, we shall be glad to have them recorded in our "Transactions." That closes the business of the meeting; and I thank you all for your attendance.

REPORTS OF COMMITTEES, PAPERS, AND DISCUSSIONS.

FIFTH REPORT OF THE GAS INVESTIGATION COMMITTEE.

(RECORDING GAS CALORIMETERS.)

[The Report was given in extenso in the "JOURNAL" for June 22, p. 677; June 29, p. 744; July 6, p. 38; and July 13, p. 101.]

Presented by Prof. J. W. COBB, C.B.E., B.Sc., and JAMES W. WOOD, M.Sc.(Tech.), A.I.C.

Prof. COBB: The work of the Research Sub-Committee during the last year was divided into two parts, which differed in character; and the results are placed before you in two separate reports—the fifth and sixth. The somewhat lengthy report on recording calorimeters comes to be made largely because of the new conditions imposed by the Gas Regulation Act of 1920, which proposes to place the recording calorimeter in a very important position. According to the new system, gas undertakings will sell thermal units; and the accurate measurement of thermal units demands two determinations—one of volume, and the other of calorific value. To be well informed on the calorific value is a vital matter. One of the principles upon which we have insisted during the discussions of the last year or two has been that unsatisfactory performance with gas-fired appliances is far more likely to arise from fluctuation in the quality of a gas supply than from any inherent defect attaching to gas of a particular quality or calorific value. There is nothing to be said for departing from the declared calorific value more than can be avoided. A legal penalty imposed in the interests of the consumer will attach to any working below the calorific value; and the gas engineer is not likely to throw British thermal units and money away by working too far above it. The amounts involved were rather startling to me on making a rough calculation. Taking reasonable figures for coal carbonized in gas-works, and assuming a price of 10d. per therm for gas, it is easy to calculate that, if all the gas-works of the country were working 1 p.ct. above the declared calorific value, it would involve a monetary loss of £400,000 per year from the delivery of therms without payment. The importance to everybody concerned of an accurate record of calorific value is therefore very obvious. It is very desirable; and it is to be hoped that it may prove practicable.

This new importance of the recording gas calorimeter led the Calorimeter Sub-Committee of the Institution to invite the co-operation of the Gas Research Sub-Committee in the investigation of the subject; and we set to work to examine as thoroughly as we could an instrument which might be regarded as representative of the best in design and workmanship which had been attained. For this purpose, we took, and believe we were justified in taking, the Simmance total heat recording calorimeter, which had already been given the blessing of Sir George Beilby and the Fuel Research Board. The results of the examination we made are disclosed in detail in the report before you. I think that the general impression which will be carried away from a perusal of the report is that the possibilities of error are so numerous, and so difficult to eliminate, that the design and construction of the perfect instrument is going to be a very difficult matter, and that Mr. Simmance is to be highly complimented on the degree of success which he has already attained. We found the instrument to be excellent in many respects—particularly if it could be given skilled attention—and are, as a matter of fact, installing it for use in our research work. We are also quite prepared to accept that, under favourable conditions, the instrument may give a reliable continuous record with little attention and over considerable periods. But the imposition of an instrument for official and penal purposes would mean more than this; and if the demand is made that the calorimeter shall give a record sufficiently reliable for penal purposes under all the conditions in use which have to be contemplated, we find that this instrument cannot meet that demand. The report is made in great detail, in order that the industry may know the nature and extent of the difficulties encountered by the designer and users of any instrument of which so much is required. We have attempted to determine and indicate the limits within which the recorder can be regarded as completely reliable, and outside which, for various reasons, it becomes unreliable.

In order that the survey might be more complete and useful, an examination was also made of the well-known Beasley instrument, which, as you know, is not a water-flow calorimeter like the Simmance, but works on an entirely different principle. Though for various reasons this instrument is unsuitable for official or penal purposes, we found it to be, in our opinion, very useful for works control purposes, and simple to operate and maintain. One criticism which has been made of the Beasley calorimeter has very little force—namely, that it records net, and not gross, calorific value. Under no ordinary conditions will this feature offer any difficulty in using the instrument to maintain a constant calorific value or tracing deviations therefrom.

I am certain that every member of the Committee would wish me to say one thing in conclusion, and that is how much we are indebted to Mr. Wood, the Research Chemist, and to his assistant, Mr. Howarth, for the substance of this report. The investigation is one which has made demands to an exceptional degree upon Mr. Wood's personal efforts; and the investigation has been carried out by him with a degree of ingenuity and perseverance which I have personally had special opportunities of appreciating, and which we should like to recognize. Our thanks are also due to the Birmingham Corporation Gas Department for the provision of laboratory facilities, and to Mr. T. F. E. Rhead, their Chief Chemist.

Mr. WOOD: In view of the comparatively small departure from the "declared calorific value" allowable under the Act, a general survey or criticism of the instrument would be quite inadequate; and it was necessary to examine in minute detail all parts of the apparatus, their function in use, and all factors influencing the recorded calorific value, in so far as they could be ascertained. Hence the bulky and detailed nature of the report. Admittedly, the examination has been exacting, but we venture to suggest not too severe, having regard to the use for which the instrument is intended. The fact that we are unable to express a wholly favourable opinion of the instrument as an unattended continuous automatic recorder, in nowise condemns it as unsuitable for the purpose for which it was originally designed—namely, that of indicating changes of gas quality to the engineer, and hence being of service in the control of gas manufacture. A most valuable feature of the apparatus in this connection is the fact that the recording mechanism works in conjunction with a reliable water-flow calorimeter, by means of which the record can be checked at any moment; the test being by thoroughly orthodox and accepted methods. In analyzing the performance of the instrument, four things must receive the very closest attention. They are: Control of the gas rate; control of the water rate; measurement of the temperature rise of the water; and thermal gains or losses to the system other than those due to the calorific value of the gas burned. The facilities placed at our disposal in Birmingham were particularly suited for a thorough testing of the recorder.

It was possible to supply gas of constant composition to the recorder for periods of thirty hours and more at a time, and to cover in turn a range of gas qualities as regards calorific value, specific gravity, and composition sufficiently wide to enable a reliable opinion to be expressed as to the behaviour of the recorder with almost any grade of gas at present supplied, or likely to be supplied in the near future. The recorder has been tested throughout under most stringent, but reasonably fair, conditions. Difficulties have been encountered; and a number of points have been brought forward which it is hoped will prove of service in connection with the design and utilization of recording calorimeters, apart from their immediate application to the Simmance instrument. It is necessary in this class of work to distinguish faulty design, faulty execution of a good design, and faults due to the inherent physical properties of the substances handled—in particular the gas and the water. Time does not permit of a detailed description of the recorder, a unique feature of which is a governor so constructed as to effect within certain limits automatic compensation for changes in temperature, pressure, and specific gravity of the gas supplied to the recorder, and to show on a chart the calorific value of the gas per cubic foot at 60° Fahr. and 30 in. barometer, without further correction being required. Provided the temperature and pressure were constant, it was found that gases of such widely different specific gravities as air, Mond gas (sp. gr. 0·85), coal gas (sp. gr. 0·5), and hydrogen were delivered at substantially the same rate. The governor is designed to operate under changes of specific gravity of the gas. But it is found that other physical properties of the gas affect the delivery to the burner; so that in certain cases gases whose specific gravities are almost identical are delivered at slightly different rates. This is of interest in connection with works using coal-gas and water-gas mixtures; a 30 p.ct.

water-gas mixture being delivered at a rate 1 p.ct. less than coal gas. The behaviour of the governor when temperature and pressure change is somewhat complex, and is discussed in detail in the report.

An extended observation of the instrument supports in a considerable measure the views reached from theoretical considerations. Briefly, the results show that compensation for temperature and pressure changes is very good for gases whose specific gravities are not far removed from 0·5. As the specific gravity departs from 0·5, compensation becomes less perfect, and in the case of some of the heavier mixtures supplied to-day would lead to errors exceeding 2 p.ct. for quite moderate changes in atmospheric conditions. Temperature and pressure changes do not affect the governor in quite the same way; so that it is not possible to state exactly the deviation of the recorder for a given change in Tabular Number, since the latter involves both these factors. Certain irregularities of the gas delivery, as distinct from explainable deviation, noted in our report, and also in that of the Fuel Research Board, as being due to the fouling of the burner, have been practically eliminated by an improved construction. The regular deviations already noted, however, still persist.

One of the greatest obstacles to the continuous operation of recording calorimeters would appear to lie in obtaining a water supply with satisfactory chemical, physical, and thermal characteristics, especially in those cases where the water flow is controlled by a " constant head " device. It is surely not asking too much to require that the calorimeter should be capable of running continuously on the public water supply of any of our large towns. Experience in this direction is very variable; and really the difficulty is not so much one of corrosion, or complete stoppage of the calorimeter due to deposits, as a gradual but uncertain reduction in the water rate, which should, of course, be constant. In Birmingham, for example, the water rate could not be relied upon to keep constant within 1 p.ct. for more than a day at a time, with the instrument examined. Even granted a perfectly pure water supply, the rate of flow through the calorimeter changes with change in inlet temperature, and with change in the temperature difference between the inlet and outlet water, due to the noticeable change in viscosity of water with temperature. Numerical values for these changes are given in the report. In a later instrument, the water system has been re-designed. This renders some of the figures obsolete as applied to the latest Simmance recorder; the variations being reduced to change in water rate with change of inlet water temperature, which, however, is still quite appreciable, and as far as we can see unavoidable. The latest arrangement is undoubtedly a great advance, and gives warning of slowing of the water rate, which can readily be restored to its initial value by very simple cleaning, and without interrupting the record. The necessity for daily cleaning with the Birmingham water supply, however, still exists; and it is likely that many other places will be in a similar plight. In the report, a water supply at almost constant temperature, not greatly removed from room temperature is insisted upon, if really reliable operation of the recorder is to be secured. The recording mechanism appears to record the temperature difference between the inlet and outlet water in a very satisfactory manner; and we can but mention here the absolute necessity for the use of properly standardized mercurial thermometers, for the determination of the calorific values by which the chart is set and checked.

In addition to the Simmance recorder, the Beasley recorder was examined. For giving indication of changes in gas quality on the works, this would appear to be a particularly convenient instrument. It is, however, not suitable for use under the Act. It is not excluded because it is a net recorder—this point being discussed at some length in the report—but because in its present form it cannot give a record directly reduced to 60° Fahr. and 30 in. barometer, and because there are no ready means of verifying the chart by a visiting inspector.

DISCUSSION.

The President: I am sure we are very much indebted to the gentlemen who have gone through all the long, arduous, and scientific work to produce this report; and it is due to them that you should give it a thorough discussion. It is quite clear that we are not yet within reach of the perfect calorimeter, and there are tremendous difficulties to be overcome before we can arrive at it. I hope the outcome of the discussion will be to clear away some of these little differences that may possibly be capable of elimination.

Mr. J. F. Simmance: I am very much obliged indeed to you for giving me the opportunity of commenting on this report on calorimeters. I think there is nothing that I can say that is not absolutely complimentary to the authors of the paper. I do not think anybody knows better than I do myself the difficulties that they must have encountered in carrying out these investigations; and I am quite certain that they wished lots of times they had not started them. You see, the governor works at such a very low pressure that it really means that these investigations have been opening out almost a new school, if I may put it that way, in gas manipulation. The governor works normally at 1/200th of an inch pressure. With the governor working at this pressure, it means that the pressure is doing actual mechanical work. The gas is not simply flowing through; it is actually moving, not only the lid of the governor, but an auxiliary balance. Many of you know how it works. I think it is cutting it rather fine. I should be very much surprised if there were half-a-dozen gentlemen in this room who have in their laboratory a pressure recorder that will indicate to 1/200th of an inch. It is quite an exception to get 1/100th; but to get 1/200th it is very rare indeed. In the case of this calorimeter, it not only does its work within limits, but it records, as you may say, the small changes of pressure caused by the very small changes of calorific power. I do not know quite, reading the paper through, whether I am here on the defence, or whether I am here simply as a critic. I cannot criticise the way in which the tests have been carried out—I think they have been magnificently carried out, and that the report is monumental. If I were Prof. Cobb and Mr. Wood, I think I would knock out all the references to particular calorimeters and get it out as a paper simply from a scientific basis, because there are lots of points there that must be useful to everyone who carries out investigations on gases in small quantities, and at very low pressures indeed. I could go through this report line by line and comment on each line; but I think it might bore you.

There are some points that really are not worth speaking of; but there are some that are. Now, where I think Prof. Cobb has been rather hard on my calorimeter is where he deals with gases of heavier gravity, and much lighter. If you buy a light car which will take two people and one in the dickey, and you put forty people into it, and then read a report on it, it is not fair to the car. [Laughter.] This particular calorimeter was made for London gas; it was adjusted for London gas. For some six weeks it had been running quite decently, well within the 2 p.ct. limit. It was sent to Birmingham, and from that moment we have not, I think, seen it. It was fitted up by the assistants, and it was worked right through its tests without the slightest assistance or counsel or advice from anybody outside, so far as I know. A calorimeter that will do this, that can be put together in this way—and, mind, it was also an old pattern—has certainly advanced gas matters a little [hear, hear] if it has done no more than that. The instrument was designed during the war (in 1916), simply because someone wanted a calorimeter, a recording calorimeter, to get some record of what he was doing. Of course, things were a little bit mixed then, and the calorimeter, as it was, was tested by Prof. Cobb, not one made at that time, in 1916, but one where the same lines had been followed. So that I think you can take it that the result is not so bad in the circumstances. Now, on this question of the accuracy of the calorimeter with mixed gases, I do not think that the report is quite fair to the instrument. I have myself watched it in actual work under changes of gravity. I mean actual work—that is to say, in testing stations under changes of gravity from 0·4 to 0·67—and every movement of the pen was carefully tested by a test on the calorimeter. It did behave perfectly; and at that time the gravity of the gas was varying certainly every half hour. The tabular number certainly was low, but gradually rose; so that I think, in spite of the report, one may take it that with that calorimeter, under normal conditions of temperature, pressure, and specific gravity, it keeps within the 2 p.ct. limit that I have always attributed to it.

I think the report can be divided up into two parts—that is to say, the calorimeter can be treated in two parts: (1) The part dealing with cumulative errors; and (2) the part dealing with errors that are inherent in the system, that cannot be got over. As regards the cumulative errors, it certainly seems that the only trouble which is a distinct trouble is the flow of the water. It seems impossible to get clean water, and, as Mr. Wood, I think, said—although I could not quite hear everything he said—even with absolutely clear water, temperature will make a change in the rate of flow. How is that to be got over? It may be got over; but I do not know how it is to be done. Mind, the limits are very small. If the water is really dirty, and it goes on accumulating in the instrument, then it naturally gets worse and worse; but it can be cleared by putting a little hydrochloric acid through it. I am afraid there is no other way of keeping the water running constantly. It seems such a little thing to get a constant flow of water; but it is not a little thing. The gas, of course, is easy. The gas is clean wherever you go. We have never had a case since the calorimeter was put on the market in which the governor failed through some imperfection of the gas. There has never been a drop of tar or anything accumulating on the governor, even after three or four years running; so that I think I can say the gas, as passed through the governor, is kept at a constant rate within the limits of the inherent defects of the governor.

There is one other point, I think, that has been mentioned, and that is the cooling of the gas. Of course, what you have heard from Mr. Wood has been just an abbreviated report, and

some of the things that I mention may not be so familiar to you as they would be to him—and, by the bye, I think this *précis* of the report, in being cut out from the body, in being compiled from the report, perhaps gives greater emphasis to some of the remarks made, because there were one or two very complimentary things said in the report, very complimentary indeed; but I have not heard so many in these little extracts. [Laughter.] This question of the cooling of the gas is put as an error. As the gas comes from the meter it runs inside another tube which is surrounded by the cold water. It is reduced in temperature, and the error avoided by this is really greater than the error that would be obtained if the gas were not cooled down. I must plead guilty to this; but not from any scientific point of view. You cannot pass a gas—a saturated gas, and sometimes a super-saturated gas—through a governor orifice without getting a deposit there; so I said to myself, "Am I going to get drops of water on the valve of the governor and get a wobble, or am I going to sacrifice a little bit of the science?" So, being more of a gas-fitter than a scientific man, science had to go; and I cooled the gas down to get all the water possible out. Now, as to the verdict that this calorimeter is not suitable for use when the question of penalization is before you, I think that is so. I quite agree with that verdict; but not for the reasons that Prof. Cobb gives—not because it requires attention, that it wants this and it wants that. I say that no calorimeter which can be reported on and criticized is a fit calorimeter under the Gas Regulation Act. "It shall include a calorimeter for the production of a continuous record of the calorific value of the gas which is being supplied." A calorimeter which is not absolutely accurate cannot comply with that. I am quite certain that it would give rise to lots of trouble if the Referees were to say, with regard to calorific power shown by the recording calorimeter, as they did in the Metropolitan Referees' Instructions, that the average of the two tests shall be deemed to be the calorific power. The Act says that it is to show the calorific power of the gas which is being supplied to the public. Supposing you have a calorimeter that has little leanings either one side or the other—a calorimeter that is within 1 p.ct., that is practically perfect. Supposing that you make a test with that instrument, and verify it as accurate, and then you lock up the instrument for a fortnight (because the tests appear to be fortnightly in the hundred-million companies), that calorimeter has to run for the fortnight without attention, without inspection. At the end of the fortnight it is again examined, and it is again absolutely accurate; but goodness knows what it has been up to all the rest of the time. It may have been just a flash in the pan that it was right. What has a recording calorimeter to say for itself in a court of law? If it is a gas examiner, you are right on the track of it, because he tells you within twenty-four hours that your gas has gone wrong, and you can always get at him. He can be cross-examined; and there are lots of ways of proving the accuracy of his reports. But a recording calorimeter, unless it is absolutely and invariably accurate, is not a calorimeter to be used under the Act. Why I speak of that with a certain amount of confidence is because I am told, on the best authority, that it is possible to make a recording calorimeter which cannot be checked by an examiner, but by which the examiner will be checked, which is absolutely accurate, which in no circumstances—that is to say, no fair circumstances—will show any errors in its record. I am told that this calorimeter is possible, and that it will be so certain that it will be received by gas managers with every confidence, because it will be a new principle. It is a thing which shows calorific power. Never mind about standard calorimeters or any other mortal thing; it is a new instrument which shows calorific power—absolutely certain. If that is so, no one will be more delighted than I, because it means that we shall be on the threshold of something quite new in the way of gas manipulation. It will help, probably, in dozens of other directions. But although it does come out, I should be very surprised if a recording calorimeter would ever be prescribed.

Mr. J. P. LEATHER (Burnley): I should like to add to the remarks of Prof. Cobb as to the indebtedness we are under to Mr. Simmance in relation to recording calorimeters. I have had experience with more than one of these instruments, and am fairly well familiar with some of the difficulties in connection with it. I think, after all, the worst thing—at any rate, so far as my experience goes—is in relation to the water. It is with us very difficult to get a water supply that will be at all constant; and if it were to be treated as a service instrument, locked up for a fortnight, and expected to behave itself for the whole time, I doubt whether—at any rate, as usually arranged—this calorimeter, or any calorimeter, would serve with anything like surety for that length of time. We have water in Burnley which is from a moorland supply—one which is rather liable to block up the mains. If any water-main in the streets of Burnley, 3 in. or 4 in. in diameter, that has been in twenty years, is broken, I think you will find trouble in getting your thumb into the middle of it; it is so full of corrosion. This, naturally, acts very badly when it comes to a question of dealing with the calorimeter; and I have come to the conclusion quite recently—if I had had time this last few weeks I should really have seriously set myself to work to see if it could be done—that this calorimeter might be maintained with distilled water. It would mean a large supply of distilled water, which would have to be pumped over and over again to feed the system, and arranged so that it would be cooled to a proper temperature by the ordinary town's water supply, which might be supplied through a fairly big sized pipe. I make a present of the suggestion to Mr. Simmance, to whom I have not had an opportunity of speaking since it occurred to me. With regard to the gas regulation, I think those who read the report know exactly what the strict test made on it says. But for ordinary purposes, the gas supply is, I consider, as constant as we are likely to get it. I do not think we can rely on the ordinary registration of the gas-meter to much below 1 p.ct. Very slight variations in the water-level of the water-meter cause a difference; and you have to be very particular. Somebody has got to be watching it exceedingly closely, to shut it off and adjust the water level irregularly, if you are to be sure that your meter is registering always with a much greater accuracy than 1 p.ct., or ½ p.ct. If the flow of gas is regulated by the governor to within 1 p.ct., I think we are doing exceedingly well. I would just like to comment on what Mr. Simmance said when he remarked that he had had no experience of anything going wrong with the governor. I do not know what the cause was, but certainly at one time during the war our calorimeter was altogether wrong in the flow of gas. On examining it, I found some sort of deposit on the little glass plate inside the governor bell. I came to the conclusion that somehow or other a little oil had been dropped into the bell. Oil is used for sealing the bell; and when the bell was taken out some time, the oil had got on to the inside of the roof of the bell and dropped down on the glass plate. Anyway, there was a peculiar deposit which we have not found since. On one occasion we had to clean the glass, which was slightly oily; but I have never found the reason for the deposit I have mentioned. I think, when the difficulties are taken into account, we have in this instrument an exceedingly good instrument; and we must thank Mr. Simmance for the amount of work that he has put into it in producing it.

Mr. ALFRED BLAKIE (of the Fuel Research Board): I think the first thing in everybody's mind is to compliment the authors of the paper on the exceedingly careful and full investigation they have made of the Simmance calorimeter. The amount of work involved must have been very great indeed. I speak with some experience, as, at the Fuel Research Board, we had an investigation of this instrument made, the results of which were published in the Fuel Research Technical Paper No. 2, in February this year.* Our investigation was not nearly so complete as the present one that has been carried out by the Committee, owing, partly, to the fact that the station was in process of formation, and much other work had to be done at the time, and partly to the fact that some of the points which have been investigated in this paper could not be investigated much better there, owing to the difficulties which several speakers have referred to—the unsteadiness of inflow water taken from the mains, and unsteadiness of air temperatures. Having said this, I think it would perhaps be best if I referred to the summary that appears at the end of this paper, on pp. 53 to 56. I will just go through it briefly, saying where our experience has been confirmatory or different from that obtained by the authors. In the first place, the first item deals with the control of the gas rate. Our tests on the gas rate, when using gases of different density, prove that the calorimeter follows really remarkably well the changes in gas density, and corrects the fuel. It does not do it absolutely; but within the limits that have been shown in this paper I think the control is as satisfactory as can be looked for. Mr. Simmance brought forward the case of gases of heavier density, and that this report had been rather hard on them. Well, possibly it may not deal with gases of heavier density quite satisfactorily; but if a gas-works are going to make gases of these extraordinarily high densities, then the design of the calorimeter should be such that it is adapted to take any proportion, so adapted that it suits these densities—that its best range covers the density of the gas being used. This, I think, is perfectly possible with this calorimeter. As to the second item in the report, our tests have shown that further changes in the gas are due to slight mechanical difficulties—namely, the burner getting clogged. We also experienced this difficulty. The burner, in process of time, became clogged with small particles dropping off from the inside of the calorimeter, and the gas rate fell off proportionately. This, I think, has probably been got round entirely in the new design. Our own instrument has been altered to the new design; but, unfortunately, we have not been able to make very many tests on it yet. We have so far experienced no trouble with this clogging. We have had only one other slight mechanical defect that might occur in any instrument almost—that is, the tubes leading from the meter became cracked, and we got a slight gas leak which was undetected for a short time, and, of course, upset the whole of our calorific value tests. The control of room temperature is desirable, and improves the governing.

As regards governing, I think, as the authors point out, it is not a matter of very serious consideration; but as regards another matter—that is, the losses or gains through the walls of

* See "JOURNAL," Vol. CLIII., p. 739.

the calorimeter—this is a much more serious matter; and I will deal with it under a later section. Now as to the water rate, which several speakers have mentioned. This we have also had some trouble with; and in this respect I consider we have been more unfortunate in our experience than the authors have been—probably, I think, owing to the fact that our water contains a considerable quantity of unfixed CO_2, which is liberated in the calorimeter as the water heats up, and forms bubbles. These bubbles will, as they grow larger, gradually coalesce, and give way somewhat suddenly. We have observed that on several occasions the rate is temporarily altered; and this is a point which may vary with every different instrument used unless great care is taken in the manufacture of the inside of the tubes. A rough surface or a smooth surface will make all the difference as to the rate at which these bubbles coalesce and come off. I have noticed it particularly after cleaning with hydrochloric acid. Immediately, for the first few hours or day after cleaning you get a much more irregular rate, owing to the surface not having settled down to its permanent condition. As regards the freeing of water from air, I think this seems to be fairly satisfactory. In No. 6 reference is made to changes of viscosity of the water, causing a change in the water rate. We also measured the viscosity changes under somewhat different conditions from what the authors of the paper did. We measured it on the instrument actually running, measuring the calorific value. We obtained a slightly lower co-efficient, about 0·24 instead of 0·4 per degree Fahr.; but this co-efficient did not allow in any way for the change of temperature between the inlet and the outlet water. Of course, this will make a difference of approximately the value shown here—that is, approximately half of the other co-efficient—because the main variation of temperature is half as much as the absolute. With regard to the errors under 4 and 6, the later modification—that is, the change in the system of controlling the water—should make a considerable difference. We have only had our instrument installed a short time, and for most of that period we have not been making a gas suitable for use in it; but what little experience we have had goes to prove that the water rate is very much improved.

As time is getting somewhat short, I will just confine myself to one or two of the more important points in the remainder of the report. Of these, I think No. 12—that is, the variation in the readings of the calorimeter owing to fluctuations in the room temperature—is perhaps the most important. We found in our experiments practically the same co-efficient that the Committee found—that is, about 1·5 B.Th.U. per degree of change in atmospheric temperature. This is due entirely to the conduction through the walls of the calorimeter, increasing the exit temperature of the water on a warm day, and decreasing it slightly on a very cold day; and at 1·5 B.Th.U. per degree it may result in a very considerable error unless the temperature is very carefully modified to prevent variations. A suggestion for minimizing this we made in our report was to jacket the whole calorimeter with the mixture of water that has flowed through it, and water at the temperature of the inflow; so minimizing the exchange of heat between the inside and outside. In conclusion, I think all will agree with paragraph 16, where it is recommended for control in large gas-works, the control of manufacture, that this can thoroughly be endorsed. It is absolutely suitable for this, and quite as good as anyone need expect. With regard to the last question—the one whether it should be used for penal clauses—I do not think this is a thing on which I can say anything, as it is a matter for the Gas Referees to settle themselves, after considering it.

The PRESIDENT: Our discussion has rather centred itself on the Simmance system, because that is the one, together with the Beasley, that has been reported on to you by the Committee. But I would remind you that there are other instruments which we shall have to examine, which are now being given inspection by the Referees—for instance, the Thomas and the Fairweather instruments. I do not know whether any gentleman is present representing these calorimeters; if so, we shall be very glad to have any remarks he may care to make for our benefit.

Mr. CHARLES FAIRWEATHER (London): You will appreciate from your Sub-Committee's report that a total heat recording calorimeter must embrace four essential automatic features—namely: A measured gas supply; a measured water supply; some form of differential thermometer; and, what is perhaps most important of all, means for automatically compensating for tabular conditions—*i.e.*, the pressure and temperature conditions of the gas passing through the instrument. The Fairweather instrument, designed by my brother, the late Mr. J. H. Fairweather, of the Brentford Gas Company, embodies all these features. A full description of it appeared in the GAS JOURNAL of June 15 [p. 628] last; but a short description here may assist in bringing the details more clearly to mind. The principal feature of the instrument is the manner in which the tabular correction was applied—by the automatic regulation of the water supply, the gas supply being maintained constant. It is important to note that the gas is cooled to the water temperature, and is measured at such temperature; and the air for combustion is both cooled to the water temperature and saturated with water vapour. The change in volume of a definite quantity of air enclosed in a vessel, is caused to move a body of oil contained in a specially designed chamber, which oil supports a float device controlling the actual flow of water; the shape of the chamber being so designed as to produce up-and-down movements of the oil and float that will give the correct flow of water. The air control consists of two tubes—one sealed inner tube containing the determined quantity of air, and an outer tube—the annular space between being utilized for the circulating water for bringing the air column to the temperature of the water. The air column is divided into two compartments, one containing oil and the other water. The oil is connected by a tube to the float chamber, and the water used for adjusting the air capacity. Water is supplied to an open vessel at the top of the inner tube, which is connected to another vessel from which depends a tube carrying at its lower end a small orifice. This orifice dips into a cup carried by a float, which, in turn, is supported by the oil in the float chamber. The water overflows the inner tube vessel, which thus acts as a weir and determines the level of the water in the tube opposite; and this level is, of course, constant. The float chamber, which is open to the atmosphere, is so shaped that the oil level is modified to cause the movement of the cup and produce a water flow directly proportional to the tabular number. Gauze filters prevent any possibility of restriction of the orifice. The size of this orifice is slightly larger than $\frac{1}{16}$ in. diameter; and with a pressure of 20 in. head, the water is supplied at such a high velocity that no fear need be entertained of the orifice getting in any way clogged.

After the water is measured, it overflows the cup, and passes over the baffle into the vessel surrounding the float chamber. From thence it flows through the funnel and pipe to the Boys calorimeter. The cup and float run on rollers with a minimum of friction. The volume of air in the sealed tube varies as the water temperature, causing a movement of the oil to be transmitted to the float chamber. Moreover, since the float chamber is open to the atmosphere the air in the sealed tube will be under a pressure equal to that of the atmosphere, slightly modified by the hydrostatic pressure due to the difference between the oil levels in the air tube and the float chamber. It will thus be appreciated that the changes in atmospheric pressure and of the water temperature will alter the volume of the air within the sealed tube, and cause oil to be forced into, or withdrawn from, the float chamber, so altering the levels of the float and cup, and consequently altering the rate of water supply. A suitable valve is fitted for introducing and sealing the air, and a water gauge with valve for the water adjustment. Oil and water will, of course, be supplied with the air valve open. A tabular gauge is fitted; and the movements of the oil correspond to the markings thereon. The gas is passed through a coil immersed in water at the bottom of the outer casing of the air-control column, and then passes through a Parkinson escapement meter. This type of meter has been favourably commented upon by your Sub-Committee in their report on the Beasley recorder. One serious fault mentioned was, however, the necessity for frequent water lining. In our first instrument, this trouble was greatly minimized by reason of the fact that the gas was cooled before entering the meter. In the instrument now before you, however, the trouble is practically eliminated altogether, as the gas is both cooled before entering the meter and is kept at the water temperature while being measured by means of a jacket of circulating water.

From the meter the gas passes through an anti-fluctuator to the burner. Water seals are introduced at suitable points, for preventing the possibility of water condensation affecting the gas flow. Air for combustion is drawn through an opening into the annular space surrounding the air column, and is brought to the temperature of the water and delivered to the calorimeter in a saturated condition through a connecting chamber. A periscope fitting allows for a clear view of the flame. The calorimeter is of the Boys pattern, modified to suit the conditions of the instrument and to ensure a free water flow. Thermometric air boxes are arranged in the hot and cold water flows; these boxes being connected by fine copper tubing to an opposed set of aneroids controlling a pen. Any change of temperature of the water alters the pressure of air in the air boxes, and so, operates through the aneroids to move the pen. The water flowing through the calorimeter passes away to waste; but a neat and simple movement enables the flow to be measured at will for check purposes. It will be observed that the position of the meter, thermometers, and water cup are conveniently placed for an ordinary Boys test to be made periodically, if so desired. However, as the water flow is accurately determined by the tabular device, it is sufficient usually to take the temperature rise as given by the thermometers to check the accuracy of the record. The rise is a direct measure of the calorific value of the gas, and is converted into the terms of the record chart or B.Th.U. by reference to a simple table of values. A ball safety-valve is fitted that will automatically cut off the gas in the event of the water supply failing. He did not wish to make extravagant claims; but this instrument has already demonstrated the fact that, with correct calibration and setting, an accuracy of $\frac{1}{2}$ p.ct. can be obtained and maintained for considerable periods without attention. The design is simple; and the sources of possible

errors can be easily detected and remedied. The overall size of the instrument can be greatly reduced if the rather unnecessary luxury of a wood casing is eliminated. In that case the floor space occupied would not be more than approximately 3 ft. 9 in. by 2 ft. 9 in.

The PRESIDENT: Do any other gentlemen wish to add to the remarks? If so, I should be pleased if they would be as brief as possible.

Dr. J. G. STEWART (Sigma Instrument Company): All the speakers who have spoken so far in the discussion have referred to the errors that you get in the water-flow calorimeter—all the troubles you get about measuring water. Each of these leads to errors. The question arises, Do you really gain by using a water-flow calorimeter? Are you not throwing away accuracy by making your recording calorimeter, which, at the same time, is a standard calorimeter? During its actual operation the Simmance calorimeter is not a standard calorimeter—not standard during the period of operation. What you have in it is a combination of a standard instrument and another—really an instrument working temporarily, like a calibrated instrument. Now, I really think that the opinion which Prof. Cobb expressed, and which seems to be held by the gas industry—that a calorimeter of the Beasley type and a calorimeter such as I have made, that they are unsuitable for final or penal purposes—is wrong. If we look at other industries, what do we find? The electrical industry is in an exactly similar position to yourselves. It sells watts or Board of Trade units; but the instrument to measure Board of Trade units supplied to the customer is an ampere meter, exactly the same as your gas-meter at present. They have to control their voltage at their power stations by a volt meter. Their volt meters are not standard instruments. You will not find a standard instrument in the electrical industry, with the exception of the electrostatic volt meter, which has a very limited use indeed. When you come to other instruments and other spheres—take pyrometry, for instance—there is a certain amount of money at risk there in using recording pyrometers. Do you find anyone using a standard pyrometer? No; the instruments which you have in pyrometry are all calibrated instruments. Consequently, I think, really, this attitude in which you actually want a standard recording instrument is wrong. It gives you a complicated instrument, an instrument that is going to be costly for a small gas-works, costly in the price of the instrument, and a costly instrument to use, because it needs a certain amount of attention. Therefore, I think, on the whole, this is a mistake. Now, an objection that might be raised to using an instrument such as the Beasley, which is not a standard instrument in itself, is that you require a second standard calorimeter to check it by, and that the small gas-works must still go in for standard calorimetry. The idea seems to be prevalent throughout the gas industry that if you measure gas and make a standard determination of calorific value you must use a water-flow calorimeter. This, of course, would involve having the calorimeter on the spot; but all the very accurate measurements of calorific value of the standard gases, those you find tabulated in your books of data, calorific value of different gases, have been done on the Berthelot bomb calorimeter and the Thompson type constant water calorimeter. The Thompson type of calorimeter is a very simple one; it is one from which the sample of gas can easily be sent from gas-works to gas examiners—a sample of about 1/10th of a cubic foot will enable a gas examiner to find the calorific value with an accuracy which is quite impossible in a standard calorimeter, since this type of calorimeter is really a much more accurate type than your water-flow calorimeter. It is somewhat more difficult to use; but there is no objection to that if you are going to have gas examiners to make the determination, because the skill necessary is not really very much more, and you can quite well expect him to acquire that skill. Consequently, I put forward this suggestion to the gas industry—that you aim at some reliability in your recording instrument, stating the percentage error which you would permit—let us say, the same sort of error you permit in your gas-meters, *plus* or *minus* 2½ p.ct.—and demand that your calorimeter should be accurate to this extent for a period of (let us say) a month, or two months, whatever you think it is possible to get, and use this method of taking samples and burning them in a Thompson type calorimeter. I think this is a real business proposition—for small gas-works, at least; and it is following the line of development of instruments which has taken place in the electrical industry and in other industries, and probably taken place on business grounds. They have had to find out which is the cheapest instrument, both in first cost and in running cost.

Dr. W. B. DAVIDSON (Newcastle-on-Tyne): I should like thoroughly to agree with the last speaker's remarks about the accuracy of calorimeters. As one who has had a great deal of experience with this instrument, I can say that the best types of calorimeter are exceedingly accurate (say) to ½ p.ct., and I would also like to say that large undertakings would be well advised never to dispense with a proper official test carried out by a thoroughly skilled operator with the best possible instrument which gives the maximum results. In my opinion, the recording calorimeter, however carefully made, will never be perfectly satisfactory. A large undertaking would lose many thousands of pounds per annum if it trusted to a recording calorimeter. I should also like to make this remark, that if you have to show the calorific value of the gas actually supplied, why not instal a recording calorimeter—which has a maximum error of (say) 2 p.ct.—in a cellar, or at a temperature corresponding to the temperature of the consumers' meters, which is not 60°, but about 40° to 48°? In this way you would gain 3 or 4 p.ct., and you will not have to correct for barometric pressure. You will also gain in the pressure of the gas you are actually using.

Prof. ARTHUR SMITHELLS: The Committee propose to follow their usual practice—*i.e.*, to defer their answer to the criticisms which have been made upon their report. I need hardly say that the criticism is most welcome, and, especially welcome is that which has been given so temperately and so kindly by Mr. Simmance. I should like to acknowledge the courtesy and the compliments which have been shown by so many speakers, and, above all, I should like to say how very handsome I think have been the words of Mr. Simmance towards our work. I am sure you will know how gratifying they must be to the Committee as a whole, to Prof. Cobb, and especially to Mr. Wood, who has carried out this work that has earned from Mr. Simmance, so competent a judge, such very high terms of praise. We have striven, of course, to be scrupulously fair. It is one thing to deal with calorimeters in general, but it is another thing to deal with a calorimeter in particular, a proprietary instrument; and we have felt all through the responsibility of being scrupulously fair to Mr. Simmance. I hope we have been; and if we have not, I hope we shall make good any defects, and supply any compliments which are Mr. Simmance's due. I do not think I will say anything more except, as I am on my feet and to avoid speaking again, that, with regard to the work of the Committee, I will say that during the past year you will judge from the reports we have been actively at work. We have had to acknowledge the kind and great courtesy of the people at Birmingham in giving us facilities; and so far as the constitution of the Committee is concerned, while we have had to deplore the loss from our numbers of Dr. E. W. Smith, as an official co-operator, we have had the advantage of acquiring the assistance of Mr. Thomas Glover and Mr. Bloor. I think you will quite understand how they added to our usefulness, and how much they brought into the common stock of knowledge to bear upon our work. I was glad to hear the President acknowledge so fully the part which the work of our Committee had played in relation to the decisions of the Government authorities with respect to the restriction of inerts. I hope all here will feel that so far we have justified our existence, that we have given a promise of future usefulness, and that we may rest certain that we have secured for long to come the support of the whole of the members of the Institution.

The PRESIDENT: I will at once proceed to move the adoption of the report. I am sure we can all give to Prof. Smithells the assurance he has just asked for. We do very highly appreciate the work that is being done at Leeds; and I can assure Prof. Smithells that we are going to be no less insistent in our demands on the work of the Committee in the future than we have been in the past. With regard to the question of these calorimeters generally, it is quite clear that there is a great deal of work to be done, and many difficulties to be encountered, before we get the perfect calorimeter. I would point out that the calorimeter that we are particularly considering now is not a standard calorimeter at all, but an instrument for common every-day work, by which the value of the commodity we manufacture and supply is to be assessed. Therefore, it is incumbent on us to use every effort to get as perfect a calorimeter as possible for our every-day use, in order that the calorific value of our gas should be accurately assessed. As Prof. Cobb said, this is a very serious matter; and when we learn that 1 p.ct. calorific value beyond that which we need send out means an abnormal expenditure of £400,000 per annum, it begins to dawn on us as to how important a matter it is. There is one thing I am quite convinced of, and I should like to assure you with regard to it, and that is that you will not have any calorimeter put upon you by the Gas Referees without the very fullest possible inquiry being made and their being satisfied as to it being the most accurate instrument that can be evolved. I have had a very long experience of dealing with the Gas Referees, and, as a result of that experience, I can assure you that we can thoroughly trust them to be perfectly fair and impartial in their dealings over this matter of calorimeters. I have the utmost confidence in their dealings with us; and I am sure we shall all be glad to feel that we can rely upon them. They have always been most fair in their dealings with us, and they are very ready in every case to listen to any suggestion we may offer to improve any instrument that may be in use for the official test. Without any further words, I will move the adoption of the report.

Mr. WALTER GRAFTON (Glasgow): I have much pleasure in seconding.

The motion was agreed to.

SIXTH REPORT OF THE GAS INVESTIGATION COMMITTEE.

(BLUE WATER GAS.)

[The Report was published in the "JOURNAL" for June 15, p. 619, and June 22, p. 672.]

Presented by Prof. J. W. COBB, C.B.E., B.Sc., and Dr. A. PARKER.

Professor Cobb: When we presented our report last year upon the steaming of vertical gas-retorts at Uddingston, which may be regarded in one sense as the making of water gas inside the retort, it was pointed out that we were going on to a piece of work which might be described as complementary—namely, the investigation of the manufacture of blue water gas in an outside generator. For the opportunity to do this we have to thank once more the Birmingham Corporation Gas Department and its Manager, Mr. A. W. Smith, Mr. John Foster, the Chief Engineer, and Mr. G. A. Bamber, who as Engineer of the Adderley Street works was responsible for the actual control of the plant throughout. The installation was of the well-known Humphreys and Glasgow make, without a waste-heat boiler. The tests were so arranged that we believe the results can be taken as representative of good water-gas practice under normal works conditions; and naturally in some respects they are not quite so good as might be obtained under short-period test conditions. The run and blow were as far as possible divided-up into short periods, so that the progress of the gas reactions occurring could be followed; and reference to the text of the report will show the information derived in this way.

As any of you will appreciate who have attempted to do this, great difficulties have been encountered in the drawing of the samples, so as to make them representative of the working during the very short periods of time involved, and special methods had to be devised and employed. A large number of analyses and measurements of weights, volumes, temperatures, and pressures were obtained in connection with each test; and, on the basis of these figures, thermal and chemical balance-sheets have been constructed. The three complete tests gave substantially the same results, and the efficiencies of gas production as defined in the Clerk-Smithells-Cobb report were found to be 46 p.ct. and 56 p.ct., according to whether the fuel for the steam generator and turbine was taken into account or not. This is a lower efficiency than can be readily obtained from a gas-producer plant, and the difference is no doubt bound up with the fact that the making of water gas is an intermittent process, while the making of producer gas is continuous. I may be permitted to point this out as confirmation of the view put forward last year as to the thermal advantages of continuous gasification in oxygen. The heat-balance shows where the various losses have taken place. The biggest item is in the potential and sensible heat of the blow-gas, suggesting the advantage of a waste-heat boiler.

I might make one general statement at this point. The nature of our investigation—undertaken as it is on a works which has to comply with the ordinary conditions of supply—does not allow of our altering the construction of the plant that we are testing, nor modifying its working beyond a certain point. The value of the results obtained lies, I believe, in indicating for the information of the gas industry what is the actual position in what can be taken as good modern practice, what losses are occurring, and the amount of heat involved in each loss. Such information should, I believe, give some guidance to individual gas engineers as to the direction that their own experiments in construction and working might well take, in order to improve the processes in question. We are, however, finding ourselves in a position to investigate the effect of a shallower fuel-bed, and are hoping to follow this up by an examination of a carburetted water gas plant, and particularly the actual performance of an attached waste-heat boiler. Chemical balance-sheets have also been constructed (as in the Uddingston work) showing what becomes of the carbon, sulphur, and nitrogen in the blue water gas process. Attention has also been paid to the formation in considerable quantity of a very fine dust which passes the washer, deposits in the mains, and gave us trouble from weighting the vanes of the meter. It is not fine ash from the coke as one might expect, but contains sulphur and silica in quantity, and is due to a somewhat mysterious chemical interaction in the generator.

This and other matters are being followed up by Dr. Parker who has been in immediate charge of the investigation. On him and on his assistants (Mr. Kerr and Mr. Townend) has fallen the labour involved in arranging the tests, obtaining all the figures, and making the many calculations which have rendered the issue of this report possible; and the Committee would, I am sure, like to express its sense of obligation. With your permission, Sir, Dr. Parker will present a brief summary of the work for which he has been so largely responsible.

Dr. Parker: The enquiry into the comparative economies of production of different grades of gas was commenced by an investigation of the process of steaming the charges in the retorts of the Glover-West continuous vertical installation at Uddingston. The results of the Uddingston tests which were presented last year in the fourth report of the Gas Investigation Committee proved beyond doubt that considerable advantages are to be gained by moderate steaming. Seven tests in all were reported—the amount of steam being gradually increased until the last test aimed at complete gasification. It was shown that the thermal efficiency of gas production rose from 54·4 p.ct. in the first test without steam to 62·1 p.ct. in the fourth test, when the amount of steam passed through the retorts was approximately 20 p.ct. of the weight of coal carbonized, and at the same time the output of therms per retort per day in the form of gas was considerably increased. Larger yields of tar and ammonia were also obtained. Steaming beyond the amount adopted in the fourth test caused a reduction in thermal efficiency; and the seventh test proved definitely that although complete gasification by steaming in continuous vertical retorts is possible, the process is not a commercial proposition with existing plant. It, therefore, appears that steaming to the extent of approximately 20 p.ct. of the weight of the coal possesses distinct advantages in that the increased yields of tar and ammonia and of therms in the form of gas more than counterbalance the reduction in the amount and quality of the coke obtained; and, owing to the greater output of therms in gas per day, definite advantages must result from the financial standpoint. It is doubtful, however, whether steaming beyond 20 p.ct. is profitable.

The next logical step in the investigation was to examine the process of manufacture of blue water gas as ordinarily carried out in a separate generator, in order that comparison might be made with the method of steaming the charges in continuous vertical retorts. This second stage of the investigation, which was carried out on the Humphreys and Glasgow blue water gas plant at the Adderley Street works of the Birmingham Gas Department is described in the sixth report. Throughout the tests the usual routine for the particular water-gas installation was adopted, since the object of the investigation was to determine the efficiency of manufacture as ordinarily practised. Attempts to increase the efficiency by alterations in the method of working were left over for the further investigation which is now in progress. According to the practice adopted at Adderley Street, clinkering was carried out every six hours; the generator was recharged with fuel to a depth of 8 ft. every forty-one minutes; and the usual cycle consisted of a one-minute blow followed by a four-minute run divided into one minute up-steaming, two-and-a-half minutes down and half-a-minute up. During the forty minutes preceding clinkering, steaming was carried out in an upward direction only, in order to cool the clinker at the bottom of the bed of fuel. The results of the tests, which together with thermal and chemical balances, are given in detail in the first section of the report, show that the average efficiency of production of water gas was 46 p.ct.—due allowance being made for the fuel required for steam to the generator and for driving the blower. When the fuel for raising steam is not taken into account, the thermal efficiencies of gas production average 56 p.ct.

It is interesting to compare these results with the efficiencies of production of the extra gas resulting from steaming the charges in continuous vertical retorts at Uddingston, which ranged from 68·5 p.ct. in the second test with approximately 6 p.ct. of steam to 57·6 p.ct. with 24 p.ct. of steam. These efficiencies of production of water gas by steaming in continuous vertical retorts are all higher than those obtained in the tests on the separate water gas generator, even when no allowance is made in the latter instance for fuel for raising steam. At the same time, it should be remembered that the manufacture of water gas in an outside generator possesses certain advantages, the most important of which is perhaps the ease with which it may be started-up in case of emergency.

The thermal balances indicate where the heat losses occurred in the water-gas tests, and consequently where the greatest economies might be effected. The greatest individual loss is represented by the potential heat of the "blow gases," which accounts for about 20 p.ct. of the total heat supplied; and the average amount of heat lost as sensible heat in the water gas, "blow gas" and undecomposed steam was 8·8 p.ct. These heat losses might be reduced considerably by the installation of waste-heat boilers. From calculations which have been made, one would expect waste-heat boilers to raise the whole of the steam required for the generator, and for driving the blower, in which case the net thermal efficiency would be increased from 46 to 56 p.ct. It should be remembered, however, that the efficiencies obtained in the steaming tests at Uddingston, could in all probability also be improved by means of waste-heat boilers.

An alternative method of diminishing the loss of heat due to the potential heat of the "blow gases" would be to reduce the amount of carbon monoxide carried up the stack by lessening the depth of the fuel bed, or by other changes in the method of operation of the plant, in so far as such changes could be made

without prejudice to the efficient production of water gas during the run periods. It should be noted that the blue water gas plant differs from the carburetted water gas plant in that, if no waste-heat boiler is used, the potential heat and sensible heat of the "blow gases" is wasted, whereas in the manufacture of carburetted water gas it is used to some extent for the purpose of "cracking" the oil. The possibilities in the direction of reducing the amount of the carbon monoxide carried away up the stack are now under investigation.

At the end of the first section of the report, reference is made to the considerable trouble caused by the deposition of a yellow-brown powder in a finely divided condition in almost all sections of the plant beyond the scrubber. From analysis of a number of samples, it appears that the dust contains approximately 70 p.ct. of silica and 10 p.ct. of free sulphur. The small amount of oxides of iron and aluminium, and the very finely divided condition of the dust, lead to the conclusion that in all probability the silica is the result of the formation and decomposition of gaseous silico-methane during the run periods in different parts of the fuel bed. The free sulphur is probably the result of the formation and decomposition of sulphuretted hydrogen.

The second section of the report gives the results of an investigation of the changes occurring in the compositions of the run-and-blow gases at different parts of the run-and-blow periods during a complete clinker-to-clinker period. This section is proving extremely valuable in the investigations now proceeding in deciding on the best method of operation of the plant at different fuel depths.

The third section of the report contains an account of a convenient method of estimating the steam consumption of a water-gas generator from the area of the throat and the pressure of steam at the inlet to the nozzle. This method has been used as an approximate check on the more accurate method of determination from the compositions of the water gas made and the amounts of undecomposed steam, as explained in the first section of the report. This section also includes a description of a new method of determination of sulphur in coal, coke, tar, and similar substances.

DISCUSSION.

The PRESIDENT: I rise to propose the adoption of the report we have just heard. I am sure the meeting will be very glad to have some remarks from Sir Dugald Clerk, who is a great expert on the subject we are dealing with.

Sir DUGALD CLERK: This paper is one of very great importance; and it will be useful to the gas manufacturer, and also to the inventor who is attempting to design new and improved thermal efficiency methods of obtaining gas. I have read the report with very great interest, and notice that the actual efficiency in operation of this producer, producing blue gas, without taking the steam used at all into account, seems to be of the order of 56 p.ct. This is a very low thermal efficiency as compared with producers acting continuously—such producers, for instance, as we have in connection with gas-engines, using coke and semi-bituminous fuel of different kinds. There is very little difficulty with coke or anthracite in getting a thermal efficiency of at least 80 p.ct. Usually, the producer in large gas-engine works, with an engine producing carbonic oxide and hydrogen in the operation of the engine by the action of air and steam upon incandescent coke, or carbon or some other kind, has an efficiency (on full load only, of course) of about 80 p.ct. In experiments which I myself have repeatedly made on such producers during many years past, we have even exceeded 85 p.ct.—*i.e.*, 85 p.ct. of all the heat of the carbon appeared in the cooled gas used in the engine. Of course, if you could get an efficiency such as 80 p.ct. in your gas industry, it would be a very great matter, both for yourselves and for the public in getting heat cheaply, and in using a very large proportion of the total heat of the coal put into your furnaces; and this report helps in that direction. In the report of Prof. Smithells, Prof. Cobb, and myself, we did consider the question of more or less complete gasification; and we were agreed in coming to the conclusion that, if the heat losses could be combined in one apparatus—that is, if you used, instead of a separate gas producer such as is here done, an apparatus of a kind which distilled the gas from the coal, and used the heat of the blow gas for that purpose, you would probably get efficiencies very much higher than are here given. This, of course, is a puzzling problem. Several people have attempted to do it; but it has not appeared on the market yet. Undoubtedly, the efficiencies given here, together with the losses when you consider them, look very hopeful; and you should still be able, certainly, to make a mixed blue gas and a distilled gas that would have a thermal efficiency of something over 70 p.ct. I think you will come to that. I quite agree with your President who, in his address, pointed out that no such efficiency was possible at the present time; but I think an efficiency of that kind is well within your reach. Reports like this are of the utmost value, both to the industry and to the designer and inventor; and I am very glad indeed to have had the opportunity of seconding the adoption of so admirable a report.

Mr. E. G. STEWART (Fulham): In introducing this report to the members, it is stated that the investigators hope the results will be of considerable value and importance. Anyone who has gone into these results will certainly appreciate that, as I do most sincerely. I thank the investigators for the great value of their results, and the assistance they have afforded to other workers in this path in the industry. I think the results are of importance for two reasons, not only because of their intrinsic value, but because they possess an added importance over the work of any private individual through being issued under the ægis of a Committee of this Institution. It is therefore a matter of regret to me that certain statements in the report do not seem to agree with my experience and work; and, also, there seems to be, in connection with the efficiencies given for water-gas manufacture, a certain depreciation of the results which I do not understand. All the efficiencies given in this report are worked out on the basis of the gross coke consumption in the generator. Now, had the investigators allowed for the amount of usable fuel in the refuse that they pulled out when clinkering the fire, they would have increased every efficiency that they have given by 3 to 4 p.ct. The 56 p.ct. efficiency, for example, would become 60 p.ct.—and it is, indeed, 60 p.ct., because the coke drawn out from the bottom of the fire is never used in producing any gas. The investigators had a precedent for doing that, because, when they were calculating out the fuel consumption of the vertical retorts at Uddingston, they did make allowance for the fuel removed from the bottom of the furnace. Therefore, they are inconsistent.

The next point I wish to call attention to is the application of waste-heat boilers. There is a note in italics in which the Committee regret that information as regards waste-heat boilers is not available. As a matter of fact, at the time their report was written information was available. If nobody else has given it, I have done it. Also, the United Gas Improvement Company, of America, have published a lot of information. In addition, if the Committee do not choose to take the figures of other people, there were at least two, if not three, waste-heat boilers working in England where they could have got the figures. I do not say the Committee were not justified in doing what they did; but they calculated the efficiency by laying down three postulates, and the first is, in effect, that the outlet gases in the boiler should be 300° C. Now, the outlet gases we find at Fulham are considerably less than that, something like 200° to 260°; and the United Gas Improvement Company, of America, in their instructions for working waste-heat boilers, tell you to drop the boiler at once if the temperature gets up to 310°. As far as I can see, these three postulates give a figure of efficiency of the boiler of about 60 p.ct. Then they introduce a bigger boiler efficiency of 70 p.ct. I should certainly like to know what they mean by this, because they get an actual efficiency of 43 p.ct. for the boiler. That is what their figures work out to, if one takes test No. 1. The figure in the report is that a total amount of 1·475 therms per 100 c. ft. had passed through that boiler, and 69 lbs. of steam are expected from it. Now, 69 lbs. of steam is 0·76 therm; and that is an efficiency of 43½ p.ct. At Fulham, we have made measurements on our plant, and we find that we use a somewhat less amount of therms—1·44 per 1000 c.ft.—and the reason is quite obvious. Looking at the result, what you get in one way you lose in another; but we actually had 90 lbs. of steam by measurement, and 90 lbs. of steam is approximately 1 therm per 1000 c.ft., which gives an efficiency of 70 p.ct. I do not think that 70 p.ct. is an unreasonable efficiency for a water-tube boiler. If you bought an ordinary water-tube boiler and started firing it with solid fuel, you would expect to get 70 p.ct. I have taken the opportunity of calculating out, from the figures in this report, what the steam would be if they got as much heat out of the waste-heat units as we do at Fulham; and I find they would get 109 lbs. instead of 69 lbs.; they would get 118 lbs. instead of 74 lbs., and they would get 122 lbs. instead of 78 lbs. in the third case. If you make allowance for using out of that steam the steam you require for the generator and the turbine, if you take credit for any heat in that surplus steam—and I think that is quite justifiable—you get efficiencies in the case of the three tests I have mentioned of 64, 66, and 65 on the gross fuel consumption, and on the net fuel consumption of 68, 72, and 68. But at Fulham we obtained 65 and 74 in one particular test. The figure which the Committee use to compare with their tests at Uddingston is 56 p.ct.; but here, if the figures are calculated out—I do not think it can be called figure juggling, but straightforward calculation—you get an efficiency of 70 p.ct., and not 56 p.ct. I should certainly like the Committee to explain how it is they get these curious figures, because this report, as I have said, has an added weight, coming as it does from the Institution. It says that a water-gas plant has an efficiency of 56 p.ct.; and I sincerely think that half the gas industry will believe it and take it as a fact. I do not think, as the Committee have told us they are now experimenting, or are going to experiment, on water-gas plant with a waste-heat boiler, and also that they are experimenting with an improved design of fire, I can serve any useful purpose at the present time by discussing the actual results of these present tests; but, with the President's permission, I would like to submit, with my remarks, a heat balance

corresponding exactly to Tables VIII. and IX. of this report, which was published some two years ago.

This heat balance is given below:

The Heat Balance Figures of a Water-Gas Plant at Fulham, given in Mr. Stewart's Paper on "Water-Gas and Heat Conservation" ("GAS JOURNAL," *Vol. CXLIX., March 3, 1920, pp. 750, et. seq.*) *Arranged to Correspond Exactly with Tables VIII. and IX.*

—	TABLE VIII. Therms per 1000 C.Ft. Water Gas.	TABLE IX. Heat Balances Per Cent.
Heat supplied—		
A. Coke to generator	5·06	84·33
B. Fuel to raise steam to generator	0·48	8·00
C. Fuel to raise steam to turbine	0·45	7·50
D. Sensible heat air to blower	0·01	0·17
	6·00	100·00
Accounted for—		
1. Water gas potential heat	3·00	50·00
2. Water gas sensible heat	0·18	3·00
3. Steam undecomposed sensible heat	0·10	1·67
4. Blow gas potential heat	0·70	11·67
5. Blow gas sensible heat	0·46	7·67
6. Heat loss raising generator steam	0·12	2·00
7. Heat loss raising turbine steam	0·11	1·87
8. Heat steam lost and used in turbine and blower	0·34	5·63
9. Ashes potential heat	0·63	10·50
10. Clinker ,, ,,	0·00	0·00
11. Dust ,, ,,	0·04	0·66
12. Ashes, clinker, dust, sensible heat	0·02	0·33
13. Losses, leakage, radiation and convection (difference)	0·30	5·00
	6·00	100·00
Efficiency, per cent.—		
Generator and turbo fuel included	..	50·0
Generator and turbo fuel not included	..	59·1

The PRESIDENT: We have just heard some considerable divergence of opinion. There is evidence that if there is not room for criticism there is room for divergence of opinion, anyhow; I shall be glad to have any other remarks you wish to make.

There being no further comment,

The PRESIDENT said: I will therefore proceed to put the report to the meeting. It has been proposed and seconded that this report be received and adopted. Perhaps before I put it to the meeting, as there have been several criticisms by Mr. Stewart of the work of the Committee, it would be only right to ask Prof. Cobb and Mr. Parker to speak on the subject now.

Prof. COBB: In view of the shortness of time, the Committee would prefer to have an opportunity of considering the criticisms before answering them.

The report was then put to the meeting, and carried unanimously.

REPORT OF THE REFRACTORY MATERIALS RESEARCH COMMITTEE.

[The Report was given in the "JOURNAL" for July 20, p. 157]

Presented by A. E. BROADBERRY, the Chairman of the Committee.

In presenting the report of the Refractory Materials Research Committee, I wish to say that during the past year the Research has been carried on more particularly under the direction of the British Refractory Research Association, to which we are now subscribers, having undertaken to provide £150 per annum for five years. On this subject, I shall have more to say later. During the past year, a great deal of interesting research has been carried on; and that which more particularly concerns our industry has had its full share.

The first subject of the report deals with the "Softening-Point of Mixtures of Silica Brick and Clay Firebrick." This is an important investigation, as we must all appreciate. Any of our settings built with imperfect jointing materials are bound to suffer in consequence; and, as pointed out: "It is well known that the softening temperature of silica fireclay mixtures is lower than that of either constituent." Partial vitrification may be beneficial, but beyond a point is undesirable. To determine the extent to which softening is affected by proportion of mixtures of fireclay and silica with and without grog, a large number of experiments have been made and tabulated in this report. The range of experiments runs from 100 p.ct. fireclay to 100 p.ct. silica; and it will be seen that fireclay added to silica has a more rapid effect in reducing the refractoriness than silica added to fireclay. Table VI. in Part 2 of this section is full of important information; and it is pointed out that tests Nos. 22 and 23 appear to give the best results, because the material was mechanically strong, had a sufficiently small contraction, and set to a hard compact mass free from cracks not easily attacked by molten slag. Further experiments are to be tried on the benefits of adding fine silica to mixtures of clay and grog.

Almost every experiment opens up many side avenues which invite, if they do not call for, careful exploration; and progress thus becomes slow. The difficulty, if we want rapid progress, is to resist temptations in the form of side issues which beset the path at every step. That expression of my feeling is, perhaps, a good preface to the second subject of the report—viz., "The Behaviour of Clay Pyroscopes and Fireclay Bricks in Coal Gas." It will be seen that in using Seger cones it has been noted by various experimenters and investigators that, under certain conditions of slow firing, particularly in reducing atmospheres, the cones stand up at temperatures where they should have squatted. This seems to be due to a surface deposition of graphitic carbon from the decomposition of methane at temperatures above 800° C. This form of carbon seems to form a skin of very high refractoriness. Experiments have shown that fireclay test-pieces treated in the same way—*i.e.*, in an atmosphere of coal gas in an electric furnace (the gas not being used at all for heating)—show to a considerable extent the same effects. This is one of the side avenues which I personally would willingly avoid—though, on the other hand, as Dr. Mellor points out, it may lead to the discovery of a method of manufacture of a super refractory. If this were discovered, it would enable us to prove whether such a substance would retain its character under working conditions. This, I believe, Dr. Mellor considers is pure speculation, because he finishes up by saying "Drop speculations, and try."

In our straight path, however, there is much to be done—*e.g.*, the specification we set up in 1912 as to after-contraction tests is causing anxiety, because of the variety of results obtainable even from the same brick or test-piece. Though they all seem to comply with our specification, some of the results are so contradictory that the test on a whole brick will disagree with those on two halves to the extent of one experiment showing expansion where another shows contraction. It is such matters lying in our direct path which seem to me to call for serious work in order that we may help to make British products more famous throughout the world for uniformity and reliability. We want for Britain at least our fair share of the world's commerce; and it can only be secured by research, and prompt research, in the paths which will tend to make British goods more sought after than those of any other country.

Now, if you will allow me, I should like to make a slight divergence. I want to take this opportunity of asking the manufacturers in the refractories industry whether they are sure they are doing their duty to themselves, to their industry, and to their country when they withhold their full and generous support to the British Refractory Research Association. That body, which took over the results of our ten years' work, and intended to develop it phenomenally, was brought into being amid great enthusiasm under the ægis of the Department of Industrial and Scientific Research, and is conditionally State-aided. The newly-formed Association voluntarily undertook to raise a minimum of £2500 per annum; and on that firm promise the Government Department undertook to subscribe pound for pound for a period of five years. Our industry, as I have already said, subscribes £150. The steel industry also subscribes; and membership of the Association is open to manufacturers, marketers, and users. Yet, in the first year of its existence, with all its early glamour, only £1700 total has been subscribed; and there is consequently a prospect, if not an absolute certainty, that Government support will be withdrawn. What a disastrous come-down! What a disgrace to a national industrial effort! The shame should fall on manufacturers and users alike. So far as users are concerned, I would ask—Is the quality of refractories so good that they think no research is necessary or could improve it? I suggest that users would benefit to the extent of thousands and thousands of pounds by helping to improve the quality still further than it has been improved by the limited efforts our small Committee have been able to make during the past ten years.

We should ask ourselves—Are we, as an Institution, subscribing sufficient? Are gas undertakings and steel works doing all they should? I estimate that in the gas industry nearly £1,500,000 is spent annually in the repair and renewal of retort-settings; and all we subscribe is £150. This equals 0·001 p.ct., and to my mind seems ridiculous. Your Committee have sent a strongly worded protest to the British Refractory Research Association. They feel that it is not their province to suggest how the funds should be raised; but they do suggest that, even in the ranks of the manufacturers, it might be possible to proportion the expense evenly by districting the country and assessing the amount to be raised from each district, or by making a small levy on each manufacturer at per ton of clay worked. This might involve a slight modification of the Articles of Association; but what of that?

If some sort of life is not put into the Association, we shall have the sorry spectacle of the ship which undertook to carry

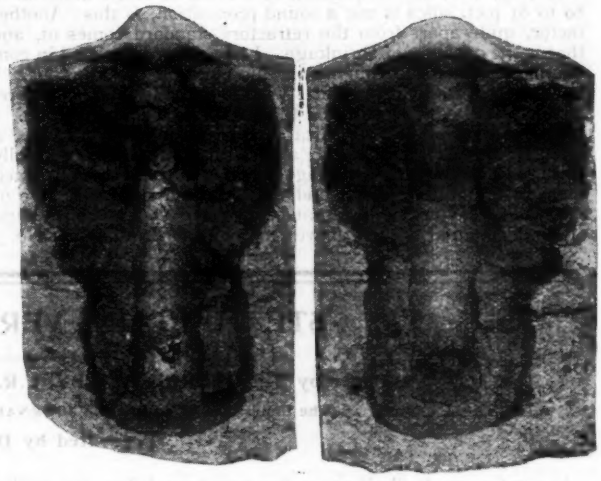
our precious cargo foundering before she has much more than left the shore, and simply for lack of the will to keep her afloat.

DISCUSSION.

Mr. THOMAS HARDIE: I will move the acceptance of this report of the Refractory Materials Research Committee, which the Chairman has presented. Mr. Broadberry has dealt with a large number of points; but I would specially draw attention to the last portion of his remarks, which refers to the possibility of the work of the Committee being cut down, owing to the necessary money not having been subscribed. Our own work in connection with the gas industry has been carried out for a number of years by our old Refractories Committee; and that work gave us a very large amount of information. We prepared from it the standard specification for firebricks and retorts. We got a small grant at that time from the Government; but a year ago, or rather more, it was thought that the work should be carried on as other Government work is carried on, under a Special Research Association, of which the Institution form a small part. To obtain the funds, it was necessary that a certain amount should be subscribed by those interested in this work. That money has not been forthcoming. The gas industry, of course, is only a small proportion of the users of refractory materials. There are other industries which are much more interested in the matter financially than we are. In any case, however, it is a most important thing to see that the work is carried on. I hope that Mr. Broadberry's appeal to everyone—both users and manufacturers—will not be without result. I should be glad if some one would second the adoption of the report.

Mr. W. NEWTON BOOTH (Woolwich Arsenal): I shall have great pleasure in doing so.

Dr. R. LESSING (London): With your permission, I should like to address myself to one point of technical importance apart from the very much larger question of financing research on refractories that has been brought before you. It is contained in the note added by Dr. Mellor to the paper on the "Influence of Oxidizing and Reducing Atmospheres on Refractory Materials." This research brought out some very interesting points in connection with the deposition under heat, of carbon, or what we may assume to be carbon or carbon compounds, on refractory materials; and the reason why I venture to address you on the point is that Dr. Mellor has done me the honour and gone to the trouble of referring to some previous work of mine in this connection which is incorporated in a patent taken out in 1911. In his note, Dr. Mellor says that the phenomenon observed by the investigators is entirely different from the result claimed in this patent of mine. To a certain extent I agree perfectly with Dr. Mellor, in that there was no claim put forward at the time for raising the refractoriness of the material; but—and this is my justification for coming before you to-day with this question—this raising of the refractoriness was a necessary corollary of the object I had in view at the time, which was the endeavour to obtain retorts which were not of a high porosity. Just ten years ago was the time when some of us tried to improve the retort material that was then being put on the market. One of the necessities in trying to improve the material was that it had to be given a rather higher porosity than was usual then. It was frequently misunderstood, I believe, by some engineers that this higher porosity was desirable *per se*. It was actually only the consequence of constructing the retort material of a matrix containing larger pieces of grog. I endeavoured to fill out the pores of the retort material with solid carbon. I interested one firm of firebrick manufacturers in the problem. They took it up, but unfortunately only in a half-hearted way. Anyway, I was able to do what Dr. Mellor recommends in the note read by Mr. Broadberry—I was able "to try it." In the first instance this was done in the laboratory, and later in a setting of retorts in a country gas-works, which were not admirably adapted for the purpose. What was done was to connect up two retorts, stop up the ascension pipe to one, which was left empty, and then allow the crude gas made in the other charged retort to go into the empty retort under pressure. It is very common practice, I believe, among engineers to try to stop up the pores of retorts by putting some tarry matter into them which would form a coating on the retort surface, but not on the surface of the firebrick particles in the body of the retort wall. In my case, I actually pressed the gas into the retort; and after only a few hours' action of this crude gas, containing all the tar vapour, in the retort, this retort would stand 24 in. pressure, or even more, without any appreciable loss of gas. Unfortunately, the results were not carried further, as I did not obtain sufficient support; but I have the test-pieces made ten years ago for the first experiments in the laboratory. I used fireclay cylinders 5 in. wide and 8 in. high. The cylinders were hollow, with an internal diameter of about 1½ in.; and through that I put compressed gas into the block. You can all see from the specimen [see accompanying photograph] the result, which shows itself in the blackening of the inner core of the test-piece. Though you fill the pores with carbon, this is not in very close combination with the fireclay. But still the surface of each particle of fireclay is in itself coated with that very dense variety of carbon described by Dr. Bradshaw and Mr. Emery, and commented upon by Dr. Mellor. I have no doubt the refractoriness of the material is very considerably raised, over and above the advantage of making the retort denser. There is one interesting phenomenon seen; and it may be of use to anyone taking up the experiments again. You will perceive that in the upper portion of the photo. the black zone extends very nearly to the periphery of the cylinder, while in the lower portion it does not go so far. I explain this by the action of the oxidizing atmosphere from the outside. I found in these experiments that you are limited in filling the whole of the retort thickness with the carbon by the atmosphere in which the retort has to work. In this case, the firing gas was supplied from the bottom. Possibly it was also slightly hotter at the bottom, and burned away the carbon formed, or did not allow it to form, while in the upper portion, where you would have to deal with spent products of combustion, this burning away of carbon once deposited did not take place. This would point in the direction that the manufacture of ready-made retorts or firebricks impregnated with carbon on these lines does not seem feasible, because it would be, in the first place, difficult to press the carbonaceous vapour or gas into the interior of the material, and, secondly, in the process of burning it would burn out again. On the other hand, for retorts *in situ* I venture to believe we have a very ready means, with the expenditure of a small amount of unpurified gas in the first instance, to save a very considerable amount of gas later on which is now being lost by leakage, and incidentally avoid the drawing in of inert constituents which I think it is in the interest of the industry and of engineers to avoid as far as possible, and certainly to keep below the point at which they make themselves effective.



AN EXHIBIT BY DR. LESSING.

Mr. G. V. EVERS: My excuse for standing before you for a few moments this afternoon must be that I am keenly interested in this paper as a firebrick manufacturer and also as a member of the Refractory Research Committee of this Institution. If it is not out of place for me to do so, I should like to congratulate the compilers of the paper, because I know from experience the enormous tedium and labour connected with researches on refractories. In connection with Part I. of the paper, particularly, I think it is reasonable to point out that it stops short at a point which casts a kind of slur on a very useful combination and a very useful material. If you refer to the paper, you will see that the lowest fusion point is that where there is a combination of 80 to 81 p.ct. of silica with the fireclay. Now, admittedly, the authors were speaking solely of, or were investigating solely, jointing materials; but I think a great many buyers of refractories could not be excused for drawing the conclusion that a brick or retort made of similar composition—80 to 81 p.ct. silica—would be a bad one. In that, they would be wrong. It is well known (there is at least one old firebrick manufacturer in this hall who can bear me out) that the first desideratum in the coke-oven business is for a material which has 80 to 81 p.ct. silica. The question is why is it that it should be so desirable a composition if the refractoriness of the material is so low? One, of course, accepts the facts without reserve. It is of a lower refractory standard than either the wholly clay brick article or the wholly silica article; but there are two points to consider. One is that, in making these experiments, the authors of the paper ground their material very, very fine indeed; it went through a 200 mesh. This is not a commercial brick or retort material at all. They say in the paper that if the grain size was increased the difference in refractoriness would be very

much less. Well, it is very much less; and, instead of being about Cone 26, it is actually about Cone 30. Another reason why I say that the composition of a brick or retort material of 80 to 81 p.ct. silica is not a sound proposition, is this: Another factor, quite apart from the refractory standard comes in, and that is the question of shrinkage. I have been interested in conducting a set of experiments on this question of shrinkage. I have charted it, and the point I wish to make is this. If you refer to the paper, you will find that No. 1 is wholly clay; No. 2 has a certain amount of silica in it; No. 3 has more; No. 4 more still; No. 5 more again; and so on, until No. 10 is wholly silica. In testing for shrinkage we made up bricks and tested them in the ordinary way, and we found that the shrinkage of the wholly clay article began at below 1000° C. The shrinkage of No. 2 began at slightly above 1100° C; the shrinkage of No. 3 began at about 1170° C.; of No. 4 at about 1300° C., and of No. 5 at about 1340° C. Now, No. 5 is the one which has the composition that gives us the lowest refractory standard. It is stable in shrinkage up to about 1350° C. After that, it has a very high expansion up to about 1400° C. Now as a practical proposition, in any furnace work of any kind, if the temperature is round about 1300° to 1350° C. (the working temperature), which is going to be the best article? The article which has no shrinkage up to that point, as No. 5, or the article which has some shrinkage, or, alternatively, some expansion? The fact that the 80 to 81 p.ct. silica brick has no shrinkage is its strong point; and I think, for a very great many purposes, this would counterbalance the fact that it is the lowest of the refractory standards mentioned in the paper.

The report was adopted.

STEAMING IN VERTICAL GAS RETORTS.

A Paper by SIR GEORGE BEILBY, F.R.S., Director of H.M. Fuel Research Board.

[The Paper was given in the "JOURNAL" for June 8, p. 542, and June 15, p. 609.]

Presented by Dr. C. H. LANDER.

As Sir George Beilby's paper has now been before the public for some three months, and has been widely reported in the Press, it does not appear necessary, at this stage to go deeply into its subject matter. It consists essentially of the report of the Chief Engineer of H.M. Fuel Research Station, Commander J. Fraser Shaw, and of the Chief Chemist at the station, Mr. J. G. King. The introduction serves to lay stress upon the important points which have been brought out, together with the opinion of the Fuel Research Board upon these matters.

Although the question of steaming in vertical retorts is, of course, of the first importance to the gas industry, it did not appear very specifically in the programme of work originally contemplated by the Board when they reported in 1917 to the Committee of the Privy Council for Scientific and Industrial Research on the necessity for, and the establishment of, a Fuel Research Station. The broad programme of the Board comprised two items: First, a survey and classification of the coal seams in the various mining districts, by means of chemical and physical tests in the laboratory, and secondly, an investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal by carbonization and gasification processes.

It was emphasized by the Board in the report referred to that, from the practical point of view, the two lines of inquiry were so thoroughly interdependent that they could be most satisfactorily dealt with side by side. The object of the coal survey is to obtain and place on record in a convenient form, data concerning the properties of different seams of coal in the various coalfields. It involves the careful collection of samples under expert guidance; these samples being tested for such particulars as chemical composition, coking properties, yield of gas, oil, and other products when subjected to different processes of carbonization at various temperatures. In this way for the different seams it will be possible to provide reliable information as to the most suitable purpose to which any specified seam should be put. The question is exceedingly important in its bearing on the economical utilization of seams or portions of seams which, owing to their friable nature or for some other reason, are often left underground and so lost to the nation for ever.

Work on this subject has been in progress under the Fuel Research Board for some eighteen months, during which time an officer has been engaged on the collation of all the various records which are considered to be reliable. Many data have been collected from papers before the Technical Societies, and a vast amount of information has been obtained from the Geological Survey. This preliminary work is now rapidly approaching completion.

In this connection the examination and analysis by standardized methods of eighteen bulk samples of coals as they are put on the market, have also been carried out at H.M. Fuel Research Station, and much valuable information as to the proximate composition and qualities of these coals has been obtained.

The Board are now about to extend this work by the establishment of Committees in the more important mining districts. These Committees will be charged with the duty of superintending the survey work in their districts. The members will include competent mining engineers or managers who are thoroughly conversant with the local seams and with the methods of working underground. One or more chemists will be included, these being as far as possible men with considerable experience in the chemistry of fuels. Each Committee will include a competent geologist thoroughly acquainted with the district. In this way the Fuel Research Board hopes to avail itself of the knowledge and experience of those in each locality who are most intimate with the fuel problems as they present themselves to the producers of coal.

The Committee will be responsible for determining where the work should begin in each district, and the order in which the seams should be explored. Samples will be taken under their supervision—these samples being subjected to assay either locally or at the Fuel Research Station. Upon the results obtained from such samples, and assisted by the advice of the local Committees, the Fuel Research Board would if necessary carry out experiments upon a works' scale on seams where such information would serve a useful purpose. Typical data obtainable from such experiments would be:

(*a*) Suitability for production of gas with bye-products.
(*b*) " " " " coke " "
(*c*) " " " " oils " "
(*d*) " " " " smokeless fuels "
(*e*) " " use in pulverized form.
(*f*) Suitability for briquetting.
(*g*) Suitability for steam purposes.
(*h*) Any other suggested uses.

Work on steaming in vertical retorts—which falls into the second portion of the programme of the Board—was primarily instituted as a result of the inquiries of the Fuel Research Board, into the question of gas standards, which had been referred to them by the Board of Trade within six months of their establishment. You are familiar with the recommendations which formed the basis of the new Act, and which rendered it possible for the first time to afford to gas undertakings a wide latitude in the selection of their own standard calorific value. The Act permits a much wider choice of materials and methods adopted by any gas undertaking.

Sir George Beilby, who first executed experimental work in the Oakbank retorts during the early eighties, had been following with great interest the development of the vertical retort in gas practice. His experience led him to look upon the increase in the availability of heat units obtainable by steaming in vertical retorts as an important subject for study at the Fuel Research Station; and it was at the same time abundantly evident that experiments with coals in vertical retorts must be included in the larger scale work in connection with the Coal Survey.

In 1918, therefore, Sir George, in conjunction with Mr. W. H. Burton, made a careful study of the various types of vertical retort then upon the market, coming to the conclusion that the one which lent itself most readily to the kind of experimental work which was in prospect, was the Glover-West. This decision was prompted by the ease with which the temperature in these retorts could be varied and regulated from top to bottom, by means of the independent combustion chambers. A contract was therefore placed for a setting of four Glover-West retorts, capable of carbonizing 10 tons per day. Some alterations were made in the firm's standard design, in order to adapt it to the methods of measurement which had been adopted by the Fuel Research Board as a standard for their work.

The retorts are fired with washed fuel gas supplied under constant pressure from an outside source, the measurement of which can be effected with great accuracy. The air supplied is also under thorough control, being under uniform positive pressure. A heat exchanger of special design is placed at the top of the retort, in order to pre-heat the air by the outgoing flue gases. A detail of considerable importance is the installation of a separate boiler for the supply of steam for steaming purposes. The feed water is weighed into the boiler, and the percentage of steam is accordingly determined with greater ease and accuracy than is possible when reliance has to be placed upon flow through calibrated orifices.

In his introduction to the report Sir George Beilby points out that the necessity was recognized from the outset of dealing with

many different types of coal, since differences of type, which have little significance in carbonization in horizontal retorts, become of the greatest importance when carbonization is carried out in those of the continuously working vertical type. In the present tests three types of coal of widely differing properties have been used, these being obtained from Durham, Yorkshire, and Lanarkshire. A much wider range will, however, ultimately have to be dealt with.

Sir George further is of opinion that from his earlier experiences of working continuous retorts, the most practical starting point for such a series of trials as are here presented would be one using about 5 p.ct. of steam, as it appears to him that this percentage is the minimum necessary for the successful working of any method of continuous drawing. The earlier tests were, therefore, made from this datum point. Later on, however, when it became necessary to correlate the results obtained by the Fuel Research Station with those at Uddingston, it was obvious that for purposes of comparison steamless tests would be necessary.

For each series of tests the only variable has been the percentage of steam used. The other factors—such as throughput of coal per hour, temperature in the various stages, degree of exhaust, and the general conditions of condensation and scrubbing—were kept as far as possible constant throughout all the tests. A log is given for all the experiments. It includes those preliminary to each test, and those where partial success only, or failures occurred, in order that experts may be able to judge for themselves as to the trustworthiness of the final results. The results obtained by the Uddingston tests are also given, side by side with those of the Fuel Research Station; and, in order to correlate the two sets of experiments, tests were carried out with Lanarkshire coal.

The immediate results of the inquiry as they appear to the Fuel Research Board will be found in the report.

DISCUSSION.

The PRESIDENT: We have had this very valuable report in our hands for some time. Doubtless, we have all studied it, and we have heard a very clear *résumé* of the salient points in it. I hope we shall have a good discussion on the subject matter of the paper. It is one of the utmost importance to us, as showing clearly the great extent to which we can go in the direction of increasing our yield of gas per ton of coal. We have seen figures showing a most important increase in therms per ton of coal; and that is the point to which we wish to devote our attention, and to do it in the most economical manner. If we are to have cheap gas we must have cheap coal in the first place. That, of course, is the crux of the whole matter. After that, we have to deal with the coal so that we get the greatest possible gaseous production from the coal in therms; and it is work such as forms the basis of this report and of the other reports we have had from our own Investigation Committee, that will enable us to do this.

Mr. THOMAS GLOVER (Norwich): I think it is a fine compliment to the gas industry, as fuel suppliers, that the Fuel Research Board should have devoted, at this early stage of their investigation into the fuel supplies of the country, such an important part of their work, and have erected a working plant, in order to prove what can be done in the way of getting gaseous heat units per ton of coal. I think we owe a great deal to the Fuel Research Board for their decision to carry out this important experiment. I have one or two questions to ask with regard to the figures in Table No. 1, which no doubt you have all studied. The tests in the first place, as shown in this table (although I think they were not worked out in this sequence at the station) show the results without steaming; then with 5·06 p.ct. of steam; then with 12·44 p.ct., 20·5 p.ct., and so forth—the throughput of coal being maintained in the retorts at about 2½ tons per retort per day. This compares with from 25 to 28 cwt. in the best practice with horizontal retorts; so that there is a very considerable increase in the throughput per retort. One of the very interesting points to my mind is the fact that while 5·06 p.ct. of steaming—that is, per cent. on the coal used—gives us 84·9 therms, as against 71·26 therms without steaming, less heat is absorbed in the process. This is a very curious phenomenon. Some of us would perhaps put a mark of interrogation against the 10·64 therms of heat supplied to the setting; but there must be a reason for it. I am speaking now of the middle tests, the Mitchell Main, the typical Yorkshire coal. Now, as the water gas process is an endothermic reaction absorbing heat, one would expect the fuel consumption to go up as the gas output went up; but apparently there is some reaction of which we know very little. Part of it is accounted for, no doubt, by the fact that this excess gas, as it is called in the report, is not a water gas, and part of the distillation in the upper part of the retort is undoubtedly taking place by the action of the steam and by the action of the hot water gas—the sensible heat of this hot water gas carried through the retort from the bottom upwards through the coal giving its first distillation in the upper part of the retort. This fact is very reassuring, because it at once shows that the process is an economic one; that steaming in vertical retorts takes less heat to give these extra therms (19 p.ct. extra therms); and if we have to supply less heat for this in the form of steam or in the form of producer gas, then it makes for very considerable economy. The report says it can be asserted with confidence that if gas of 400 to 430 B.Th.U. can be supplied or made by this process, then success would be assured. But we do not need to confine ourselves to this low calorific value gas. The 5 p.ct. of steaming gives us 19 p.ct. increase of therms, and that gives us a calorific value of 517 B.Th.U. Some of us would probably be tempted to go a little further than 5 p.ct. of steam, and my ideal at present is 480 B.Th.U. I may alter that one way or the other according to what I find most economical, when I have my vertical retort bench finished, and am able to work it. I am expecting some very interesting times in experimenting in this process of steaming and finding the most economical limit, and also finding the type of coals which will suit our purpose to the very best advantage. There are many other points which one would like to discuss. The graphs which are published in the paper are extremely interesting. They are rather difficult to understand, I am bound to say; and there is one, fig. 5, that I would suggest to the members who want to study it a little further should be tinted to show the different sections—the steam and the gas, and where one overtakes the other, and so forth. If different colours were used, it would make the graphs very much more understandable. Fig. 8 also would be very much better, as well as the others, if they were explained a little further by those who have been responsible for taking them out. They are extremely important, because they show the cost of producing water gas by the steaming of vertical retorts, as compared with doing it in the ordinary water gas plant; and it shows very much to the advantage of the vertical retorts. I am bound to say, however, that the graphs are rather difficult to follow. Now, with regard to the production of ammonia, I know this was probably one of the difficulties of the Fuel Research Station; and I think the experimenters there deserve our sympathy in having to get at the liquid products from an experiment of this kind. We know how difficult it is to measure accurately the liquid products from distillation on this scale, and particularly to get accurately the quantities of tar and the quantities of liquid separated, and accurately measured. We will assume, however, that the very great care and the very delicate apparatus which was used have given us the amounts accurately. I see that they only credit the Mitchell Main coal with making 16·07 lbs. of sulphate of ammonia, and that when 5 p.ct. of steam was used, it went down to 10·64 lbs., and then, with 12·44 p.ct. of steam, the amount of sulphate of ammonia is 16·11 lbs. [These figures are not accurate, and were taken in error by Mr. Glover from a lower column in the table. The point is put right in Commander Shaw's reply.] That is contrary to our experience, and contrary altogether to our expectations. We believe that if we provide a suitable atmosphere inside the vertical retort during the process of the liberation of nitrogen, if hydrogen is present, and especially present in the nascent condition, there will be a very considerable increase in the production of sulphate of ammonia. These results do not bear this out. I think that the ammonia research, which comes on a little later, which has been conducted at the Leeds University by Dr. Monkhouse, will show this very clearly. The results are not in this respect very consistent—either for want of right conditions, or something—because when you come to the Lanarkshire coals, you find that the increase in ammonia production is very considerable. It starts with 32·6 lbs., and rises to 34 lbs. and 38 lbs. and 39 lbs. of sulphate of ammonia per ton of coal by the process of steaming. Why should it be so with Lanarkshire coal and not so with Yorkshire coal? These are subjects, perhaps, for further investigation by our good friends of the Fuel Research Board, and well worthy of their skill and further trouble and research. I put it up to them to do it.

Mr. GEORGE HELPS (Nuneaton): This paper is undoubtedly for scientific minds, and scientific minds only; but as there are some of us here who are slightly touched with the commercial aspect, we should like Sir George Beilby, if possible, to embody it in some tables which will show the commercial value of these tests—these far-reaching tests—which he has made. For some of us to be discussing here the scientific aspect of a problem which at most provides about 8,000,000 B.Th.U. per ton of coal—true, it provides coke, tar, and other products—when from the same ton of coal, 20,000,000 B.Th.U., or something like it, can be provided and distributed to the consumer, it seems to me, if I may put it mildly, to be wasting time. We have heard it said time and again that the research work of the gas industry cannot otherwise be dealt with than by being put into the hands of scientists. I stand up here and say that that is nothing short of nonsense. I am not speaking with disrespect of scientists, because we want scientists as well as practical men. Most of you know that gas is passing through a transition stage, and we are all aware that the Government has so far been satisfied with what has been done (not necessarily by the scientific man) that it has removed all restrictions regarding the distribution as well as the manufacture of gas, and I do not think that we are making half enough of this fact. The people who are responsible for the removal of these restrictions, whoever they may be, are worthy of our deepest respect and everlasting gratitude. Nothing has ever happened in any industry the last hundred

years to compare with this. If there is anyone here who does not believe that 20,000,000 (or something like that number) B.Th.U. can be made and distributed to the consumer from a ton of coal, let him get down to it and see for himself. He is not asked to accept any statement of any man. All these things are open to demonstration, and demonstration not restricted to the scientific man. It is open to the individual layman; and I do hope that Sir George Beilby, if he is not able to compile the table I referred to, will find some commercial-minded man, and ask him to get out some tables which will show us the commercial value of this excellent paper, which he has honoured the industry by presenting to it.

Mr. Thomas Hardie (London): I am sure everyone has read this paper with the greatest interest; and it has been specially interesting to all who have vertical installations. In the summary which has been given, reference has been made to a paragraph which drew my attention when I first read the paper. It is that "it was recognized from the outset that it would be necessary ultimately to deal with many different types of coal; for differences of type which have relatively little significance when carbonization is carried out in horizontal retorts become of the greatest importance when it is carried out in continuous vertical retorts." The thing that has struck me in reading this paper is that I do not see any confirmation of this statement in the body of the paper. The results which have been obtained in the continuous verticals at the Fuel Research Station are very much what might have been expected from these coals in horizontals under ordinary working conditions—that is, without steaming. Therefore I cannot see where this difference arises. When we come to steaming, of course, that is a different matter altogether; and there may be reasons in connection with difficulties that may arise in handling coal. But even then I am rather inclined to think that the author had in his mind the difficulties that were thought to exist in handling such coals as Durham coals in continuous retorts. The experiments carried out by the Fuel Research Board rather indicate that the much-prized Yorkshire coal has made more difficulty than the Durham coal. This to me has been a matter of some surprise; but I am pleased to find that they have been able to handle Durham coal satisfactorily. My experience has been that any coal can be carbonized satisfactorily in continuous retorts, provided that the temperature and throughput of the retort are kept in their proper proportion. There is in the paper a table in which are summarized the results of steaming up to 21 and 22 p.ct.; but there is one important omission from that table. It is what has happened to the coke in the retort. In referring to Table I., where these particulars are set out in full, I find that the loss of coke per ton of coal carbonized on the Consett coal was 0·26 cwt., on the Mitchell Main coal 1·22 cwt., and on the Lanarkshire coal 1·25 cwt. You will see from this that there is a very great difference in the loss of coke in the retorts during the process of steaming to the same extent in each case—21 to 22 p.ct.; and when it is worked out, the results are rather astounding. The additional therms obtained per pound of coke lost amount in the case of the Consett coal to 0·38 therm, with the Mitchell Main coal to 0·17 therm, and with the Lanarkshire coal to 0·13 therm. Working this out on gas of 300 B.Th.U., it is equivalent to 7·9 lbs. of coke lost per 1000 c.ft. of gas estimated made in the case of the Consett coal, 17·6 lbs. for the Mitchell Main coal, and 23·1 lbs. for the Lanarkshire coal. Therefore I think that the statement which is made in another portion of the paper, that Consett coal is obviously less suitable for steaming, requires some modification in view of these figures. Of course, there may be other things; but it is very important to note the small amount of coke used for the large quantity of gas obtained. I do not think the additional quantities of tar and ammonia, though they were larger in the other two cases, would make up the difference to the gas manufacturer for this very much smaller quantity of coke lost in the vertical retort.

There is a point I should like to put with reference to the tests made of the water gas which has been used for fuel. I notice that while the quantity of both the coal gas produced and the waste gases was obtained from continuous tests, or from tests of continuous samples, in the case of the water gas used for heating the settings it is simply said that tests were made once in twenty-four hours. They may have a very steady process of making water gas; but I do not think a test once in twenty-four hours is sufficient. It does not compare well with the accuracy in other portions of the experiments. With regard to the practical working, it has been suggested that the steaming of retorts may be limited by the trouble which is experienced through the coal sticking in the retorts. That has not been my experience. In fact, I may say that with increased steaming, so long as temperatures have been maintained, there has been no trouble with sticking. Such trouble as there has been, if any at all, has been reduced. Another comment upon the question of steaming is the frothing of tar in the collecting main. This is a matter for which, also, I do not think the blame can be put on steaming. The frothing has taken place in my experience without any steaming at all. These tests have been made under somewhat different conditions, of course, from those it is usual to work under in gas-works. As to the maintenance of a constant throughput of coal. It is rather surprising to me, in looking through these figures, to see the quantity of coal that the Fuel Research Board have been able to maintain as throughput with these retorts while steaming to so large an extent. One would naturally think that the maintenance of a temperature in the combustion chamber of 1250° to 1300° would mean that the temperature in the retort itself was higher if there was no steaming going on than with 20 p.ct.; and we expect then that, if the conditions are right for the coal being worked when there is no steaming, they cannot be exactly right for working when there is steaming. I think it would be well, if the Fuel Research Board are proposing to carry these experiments further, for them to vary the throughput and maintain the steam, and see what the results are then. In general practice, we have found it necessary, in order to obtain the best results with steaming, to reduce the throughput of the retorts. I would like to express my appreciation of the advantages to the industry of this report, which is so full of important information that has been secured under conditions that it is impossible for us to obtain ourselves in our own works.

Prof. Cobb: It was apparent to all of us who had to meet Sir George Beilby during the time that he and the Fuel Research Board were preparing their recommendations to the Board of Trade on the subject of legislation for gas, that Sir George Beilby had a very real interest in the gas industry, and a strong desire that its development should not be retarded. The paper which he has just submitted to the Institution is another proof of this interest. The subject of steaming in vertical gas retorts is one which has already received attention at the hands of your Gas Research Sub-Committee; and in extending the work to other coals beyond the one to which our experiments were confined, Sir George Beilby and his staff have undoubtedly placed further useful information in the hands of the gas industry. From this standpoint, we have to thank him also for using a method of experiment and of reporting results so far parallel to our own that comparison becomes possible. There are some respects, I may say, in which I cannot but think an even closer parallelism would have been a greater advantage to everybody concerned. Sir George says that he has directed more attention to the practical issues as distinct from purely chemical considerations, and that the preparation of chemical balances of the several elements of the coal has not been included on that account. Let me say at once that I believe, and we as a Research Committee believe, that the preparation of the chemical and thermal balances was one of the most important parts of our work. When we were engaged upon the tests at Uddingston, I was told several times by men in the industry who might be trusted to be looking at the matter from a practical point of view, that they hoped we were going to secure reliable data on the effect of the steaming process as regards sulphur in the gas and in the coke; and although ammonia is under a cloud just now, it is plainly important to secure a gas and liquor rich in ammonia if its extraction is to be profitable. Sulphur and nitrogen balances have therefore a very practical value. It is true that the chemical balance-sheets which we constructed for the coal used at Uddingston are probably roughly applicable to other coals. But we cannot be certain of this; and it seems to me a pity that, when such elaborate experiments were being carried through, the results were not worked-up into the corresponding chemical balance-sheets. I do not think that Sir George Beilby need fear that the gas industry would regard such balance-sheets as of purely theoretical interest. It has evolved beyond that stage. Moreover I believe it is difficult to be certain of the results of tests of this kind on the weight-balance alone which Sir George Beilby has used, on account of leakages in the system, inwards and outwards. At Uddingston we found that the thermal and chemical balances (particularly the carbon balance) were of the greatest possible service in determining which of our experiments were to be regarded as entirely trustworthy, and therefore suitable for inclusion in the report, and which had to be set aside. The Research Committee having this in mind, and having in mind also the importance to the industry of the results which have just been put before us, was impressed with the desirability of going into the matter further from this point of view, and asked Dr. Parker to do so. Dr. Parker will himself speak upon this. There are one or two points upon which I should like to make a remark or ask a question. It is quite true that we found in our experiments that a considerable amount of steam was lost. We knew it was being lost, because we saw it escaping at times and dripping away as water. So far as I can learn this is the general experience with the plant when running under ordinary working conditions. It is advisable to recognize the existence of this loss with a view to preventing it in some way. The loss seems to have been partially prevented in the Fuel Research Board's experiments by the use of a packing at the bottom of the retorts. This is quite justified so long as it is understood to be for the purposes of experiment, but is not the condition obtaining in continuous practical work. Again it would appear that all, or nearly all, the secondary air was, before going into the setting, sent through a preheater in the Fuel Research Board's experimental plant, and could not therefore exercise anything like the same cooling effect on the bottom of the retort as if all the air were supplied cold. This would probably account for the fact that the con-

densation in the coke chamber was negligible. This again is interesting experimentally, but is not the condition of affairs in practice. Sir George Beilby's use of the superheater raises one or two interesting points. In a vertical retort setting it is possible to use the waste heat in various ways, and the designers differ in the methods they employ. It may be the most economical plan with the Glover-West installation to use a waste-heat boiler and to superheat the steam required for the retorts. On the other hand, there are some advantages in supplying hot air to the setting—one being the tendency to prevent condensation in the coke chamber. Is there any consensus of opinion on this point, or basis for a decided opinion? I would rather leave other points to be raised by Dr. Parker, whose examination of the results has been much more thorough and systematic than my own. But before sitting down I would like to say how well I know the difficulties which have to be encountered in carrying out such experiments as Sir George Beilby has described, and to congratulate the Institution upon receiving a paper upon the preparation of which so much time and labour must have been expended.

Dr. PARKER: I have read with considerable interest the paper presented by Sir George Beilby, and am gratified to find that the general conclusions drawn from the tests at the Fuel Research Board's station confirm the results that were previously obtained at Uddingston. It appears that steaming to the extent of approximately 20 p.ct. of the weight of the coal possesses distinct advantages in that the increased yields of tar and ammonia, and of therms in the form of gas, more than counterbalance the reduction in the amount and quality of the coke obtained. There also appears to be a gain from the economic standpoint. It is doubtful, however, whether steaming beyond 20 p.ct. is profitable. Although, generally speaking, the results obtained by the Fuel Research Board confirm those of the Uddingston tests, there are differences and other points in the report which ought to be considered in further detail for the purpose of endeavouring to find satisfactory explanations. Since these points are too numerous and in some instances too involved to enable me to deal with them at this meeting, I propose sending in a written contribution to the discussion. But perhaps I might be allowed to make a few observations now.

It is disappointing to find that the tests in the report under consideration are by no means as complete as they might have been made. Apparently no references appear with regard to the effect of steaming on the amounts of sulphuretted hydrogen, hydrocyanic acid, and naphthalene; and the data obtained are insufficient for a construction of full thermal and chemical balances in order that a true evaluation of the tests might be made. In the tests by the Fuel Research Board, weight-balances have been used as the criterion of reliability. Personally, I have always considered that in tests of this character, weight-balances alone do not constitute a sufficient check, since they may be affected by the amounts of air entering the plant, by the gas losses which must occur when working at or near level gauge, and by other factors. It is possible for a test to give a good weight-balance, and at the same time thermal and chemical balances would cause its rejection. For example, Test E, with Mitchell Main coal, shows a loss of only 0·06 p.ct. in the weight-balance, as against a loss of 7·2 p.ct. in a thermal-balance. Then again, although the loss in the weight-balance in Test K, with Lanarkshire coal, is only 1·91 p.ct., a nitrogen-balance shows over 8 p.ct. more nitrogen in the products (coke, tar, and ammonia) than in the original coal, without taking into account the nitrogen obtained as cyanide, and the free gaseous nitrogen which must have been produced. Possibly the higher yield of ammonia than in similar tests at Uddingston accounts for this discrepancy in the nitrogen-balance.

With regard to the percentages of steam decomposed, the amounts in the tests with Mitchell Main coal lie on a curve of the type anticipated; but in the tests with Durham coal it is surprising to find that less than 7 p.ct. of the 5 p.ct. of steam used in Test B was decomposed, whereas in Test C, with 21 p.ct. of steam, the cracking efficiency was nearly 27 p.ct. Another peculiarity of Test B is that the gas produced was of a higher calorific value than that obtained in Test A without steam. The water gas used to heat the setting was in some instances of unusual composition. This point is further brought out when an attempt is made to calculate the amounts of excess air used for combustion. For instance, the amount of excess air used in Test E is 32·3 p.ct. when calculated from the carbon content, as against 23·5 p.ct., or 8·8 p.ct. less, from the oxygen contents. One would expect the two figures to agree within 2 p.ct.

The losses of heat by radiation, convection, &c., from the setting of four retorts at the Research Station were several times greater than the values assumed to represent the corresponding losses from the settings of eight retorts at Uddingston. This was to be anticipated; but doubt is expressed in the Research Board's report as to whether the heat losses from the Uddingston settings could have been as low as either 10 p.ct. or 7·5 p.ct. which were the figures suggested. I have therefore used the results in the two reports for the purpose of calculating these losses from the Uddingston settings, and have obtained values very near to those given in the Uddingston report. On Test J without steam the yield of straight coal gas, 11,800 c.ft., appears to be high for Lanarkshire coal containing 10 p.ct. of moisture. It is certainly much higher than the 9367 c.ft. obtained at Uddingston, which lower figure compares quite well with the 9670 c.ft. previously obtained in horizontal retorts, and the figure of 9870 c.ft. resulting from a test by Mr. Kennedy in 1915 in Glover-West continuous vertical retorts with 5 lbs. steam pressure on 1/16-inch nozzles. However, these and other points can be dealt with more satisfactorily in further detail in a written contribution.

The PRESIDENT: If no one else wishes to speak I will ask Commander Shaw and Mr. King, the Chemist to the Fuel Research Board, to reply to the discussion.

Commander J. FRASER SHAW: I think I had better try to answer a few of the questions as far as possible without any preliminaries. Mr. Thomas Glover mentioned a fact which, when we came across it, did surprise us at the Research Station—namely, that on the first application of steam there was certainly less heat required in the combustion chambers for the satisfactory carbonization of the coal. This thing was a surprise to us, and to begin with, quite upset our calculations. Perhaps we ought to have expected it; but as Mr. Glover did not, apparently, expect it, perhaps we can be excused. We have given some sort of explanation of it in our report; and it would seem that the actual reduction in the quantity of heat supplied to the combustion chambers is brought about by the utilization of the heat in the incandescent coke at the base of the retort. Without any steam being supplied to the retorts, the coke comes down from the retort in an incandescent state, and the castings at the base of the retorts get very hot indeed—in fact, they get red hot. They get so hot that we have decided that we really cannot afford to do any more tests without putting steam through the retort; and of course, when the steam is added to the retorts, the heat is made use of in the reaction between the steam and the carbon. It is also transferred to the upper part of the retort, and certainly it does assist in the carbonization of the coal. Then Mr. Glover mentioned the graphs. It is certainly very much easier to read your own graphs than anybody else's; and I do not think it is possible for me here and now to give any explanation of the graphs. I do, however, realize that they are rather difficult to understand. They were made out with the idea of enabling people to look at them and read straight off from them what they required. But I am afraid they must have failed in this, because of Mr. Glover's difficulties. I think his advice is very sound with regard to the colouring of them; but that was an impossibility in the form in which the report has been published to you, and also in the form in which it has been published as a report by the Scientific and Industrial Research Department. The Stationery Office, as far as we are concerned, will not look at the idea of having any coloured reports; and I really do not think it is possible for me to explain them any further now without having an illustration on the screen, which has not been arranged for. Therefore, I am afraid you must be content with the information given in the text. In the final reply, we will endeavour to make them a little more clear, if we can. I do not think it is possible for me to explain very particularly even figs. 7 and 8, which illustrate the difference between the production of a certain quantity of gas by means of a straight water gas generator, and enriching the gas to make it correspond to what we have called (I think we took the term from the Uddingston report) the excess gas, which is made when steaming in vertical retorts. With regard to ammonia, which Mr. Glover spoke of, I have been talking to him since; and the figures he mentioned were not the ones he meant to quote. The actual figures were not those he quoted; but I understand they are still considered to be lower than ought to be expected from a similar coal. The actual figures are 16·27 lbs. of sulphate of ammonia from the Mitchell Main coal with no steam; 18·75 lbs. with 5 p.ct. of steam; 21·8 lbs. with 12·5 p.ct. of steam; 21·2 lbs. with 20 p.ct. of steam; and 21·9 lbs. with 30 p.ct. of steam. These figures are higher than Mr. Glover mentioned; but I am afraid I am not able to explain why it is that they should be lower than would be expected in ordinary practice. We certainly went very thoroughly into the matter, and that because we felt, to begin with, we were rather low; but we were unable entirely to discover any reasons for altering them. Mr. Helps had something to say in regard to the commercial value that might be put on the figures. This is a thing which it is impossible to do, because the commercial value of the products in different cases must vary; and the object of putting the graphs in was to enable anybody to decide about the commercial value for himself. We hoped that they would enable anyone to decide this particular point for himself. By means of fig. 3, for instance, we hoped that by looking this up anybody would be able to decide what would be the yields of gas and tar and other products, and what would be the cost for any particular calorific value of gas which he required. Supposing, for instance, it was decided that the gas required was 450 B.Th.U., by looking at the bottom of the diagram in fig. 3 it would be seen that if the calorific value was 450 B.Th.U., the quantity of gas would be 23,500 c. ft. per ton—*i.e.*, a matter of 105·7 therms. Then, by transferring upwards, it would be seen that the steam required

for producing the gas would be 24 p.ct. of the weight of coal carbonized. Of course, we are talking now on the basis that the throughput of the retorts would be 2½ tons per day, which we worked at, and that the carbonizing temperature would be 1260° C. Then, going up the graph, we see that the yield of tar would be 13·5 gallons; that we should get 22·5 lbs. of sulphate of ammonia; and that there would be an actual yield of 13 cwt. of coke per ton, of which 2 cwt. would be breeze. If all these points were shown, the local markets for the products would be known, of course, in any particular place, and from this could be made-out what would be obtained from the ton of coal, and the cost of supplying it would be a matter of 22 therms (that will be seen in the centre diagram) of water gas, which would have to be put into the setting, in addition to what we have called the heat equivalent of the setting, which is a fixed factor that also must be found out by each particular gas manager for his own setting. It was on these lines that we hoped we had really put up something which could be made use of commercially; and I do trust that there may be after all some use even for these graphs. I suppose, perhaps, the reason I am hopeful of this is that they are, as you may say, my baby; and so I rather want them to be used. Mr. Hardie made some very interesting remarks, with which I had to agree very largely, even though he was criticizing something which we had said in the report. With regard to sticking in the retorts, Mr. Hardie did say that he had not had any difficulty in this direction, provided one altered the throughput and the temperature to suit. Of course, under the conditions in which we tested, we were unable to alter the conditions; and therefore, we had simply to put up with the sticking; and we certainly got it. It is quite true our experience showed that the Yorkshire coal gave more trouble in passing through the retorts than the Durham coal, and this was a great surprise to us from what we had been told. I think that I had, perhaps, better reserve any further remarks for the written reply which may be made.

Mr. J. G. KING (Fuel Research Station): With regard to what has been said by Dr. Parker—that the only balances which we had shown were weight-balances—that is true; but it does not follow that we have not been paying attention to the elementary balances. These have, to a certain extent, been watched as things went on; and no test has been put in without a chemical balance having been considered as well. We have not any actual figures now; but there have been several preliminary tests which have been fairly satisfactory in themselves; but they have been left out because they were not satisfactory in this respect. With regard to the testing, it has all been carried out, apart from that, as carefully as possible. Mr. Hardie said a sample of water gas had not been carried out as carefully as the others in the beginning of the report. This is not stated in the part on analyses, but it is stated that a sample is taken every 24 hours, as well as average samples three times during the 24 hours; and analysis of these 24-hour samples is carried out, and the calorific value calculated from them, and compared with the other results.

The PRESIDENT: I hope we shall hear more about it in the written communications. I will ask you to express in the usual manner your very hearty thanks to Sir George Beilby and Commander Shaw, and those gentlemen who were concerned in the production of the paper.

The vote of thanks was accorded with acclamation.

EXTERNAL CORROSION OF MAINS AND SERVICES.

By J. G. TAPLAY.

Much has been written in connection with the external corrosion of gas-mains and services. The author submits the present communication in the hope that it may be found of further interest.

There are frequent cases where a trifling corrosion is going on inside the pipe, while at the same time active corrosion is rapidly proceeding on the exterior.

Corrosion may be brought about in the following various ways: (1) Electrolytic—caused by stray currents from faulty electric cables. (2) By acid earth. (3) By alkaline earth.

There are other causes of corrosion brought about where pipes are laid in soil containing brackish water, and again there are other cases where pipes have been laid in clay soil, and have become softened to such an extent that the metal could be cut with a knife. This latter point was observed by Dr. James Campbell Brown several years ago. On the present occasion the author desires to call attention to two forms of corrosion which have been investigated recently. That taking place in: (*a*) Acid earth; (*b*) alkaline earth.

CORROSION OF IRON SERVICES IN ACID GROUND.

During January, 1919, attention was drawn by Mr. Stephen Lacey to the corrosion of a high-pressure steel service situate in Shaftesbury Avenue, London. On exposure this pipe was found to be badly corroded, although it had been wrapped in hessian and bitumen.

CHEMICAL EXAMINATION OF THE ACID SOIL.

Some of the earth surrounding the pipe was removed for analysis; and it was found to contain acetate of iron together with dextro-glucose, which latter showed evidence of original cellulose matter in the earth. Here it may be remarked that the ground in which the pipe was laid was not virgin soil, but was what is known as made-up ground, containing all sorts of rubbish—including decaying vegetable matter.

It became necessary to examine this earth further; and on analysis it was found to contain (in addition to acetate of iron) calcium acetate, calcium formate, calcium nitrate, and calcium nitrite; the presence of all these being evidence of bacterial action.

BACTERIAL EXAMINATION OF THE ACID SOIL.

First, any micro-organisms present were isolated from each other by sowing a little of the well-mixed soil in nutrient gelatine medium contained in a covered shallow glass dish. By this means several distinct colonies of micro-organisms appeared in a few days. Some of these organisms appeared on the surface of the gelatine and some below the surface.

Subcultures of traces of each of these colonies were made in other suitable media—such as peptone water, neutral glucose solution, litmus milk, egg albumen solution, neutral glucose-peptone beef-broth, glucose-lactose solution, and on potato—all the above media being previously sterilized before inoculation with the bacteria. By means of an examination of these subcultures both chemically and microscopically it was proved that the cause of corrosion of the service-pipe was due to the presence of the bacterium producing acetic acid fermentation. The author is unable to explain the presence of these micro-organisms in this particular soil.

The following experiments were made in order to reproduce the conditions actually existing in the earth surrounding this particular service pipe:

(1) Eight different kinds of vegetables were mixed and sterilized, repeated infusions with distilled water being made, followed by drying, until all natural acid (sulphuric) was removed. The dried sterilized matter was then ground to a powder, mixed with sterilized distilled water and sterilized chalk, and afterwards inoculated with a trace of the acetic acid bacillus. In two or three days time the whole mass had become expanded by reason of the formation of carbon dioxide. An examination of the residue showed that the chalk (calcium carbonate) had become converted into calcium acetate. This is evidence that this particular bacillus is able to convert the cellulose in the vegetable matter into acetic acid. This conversion does not take place in one stage, as the following experiment will show.

(2) A trace of the acetic acid bacillus was added to about a quart of sterilized neutral glucose-peptone beef-broth, and in a few days time acetic acid was found to be present. Eventually the liquid was distilled, and the following organic compounds were isolated from it: (*a*) In the first portion of the distillate, alcohol, acetone, and aldehyde were found. (*b*) In the second portion volatile acids (such as acetic, formic, butyric, and propionic) were present. (*c*) In the third portion fixed acids (such as lactic and oxalic) were found.

Of the above organic compounds caused by bacterial action on the vegetable matter, acetic acid is by far the greatest in quantity, and will do the greatest damage to the service-pipes.

A new steel service-pipe was laid in place of the corroded one, and a coating of hydraulic cement was built-up round it to protect the pipe from acid corrosion. This method of protection may be considered by some to be costly. It is, therefore, suggested that a heavier coating of hessian and bitumen might answer the same purpose.

CORROSION OF IRON SERVICES IN ALKALINE GROUND.

Corrosion in this case may be brought about by laying the iron services in earth of an alkaline nature, also where iron fittings are fixed in plaster—*i.e.*, in the walls of buildings, &c.

In all these instances water must be present. Examples of this form of corrosion have been submitted and studied. In every case the corrosive agent was found to be calcium bicarbonate, both in the earth and in the wall-plaster. Experiments were made to determine the effect of calcium bicarbonate and water on wrought iron, steel, and cast iron.

Machinings of the several samples of iron were obtained and passed through sieves to ensure the specimens being of the same size. In each case 2 oz. by weight of the machinings and

½ oz. by weight of ordinary commercial, powdered chalk were placed in a vessel, which was then completely filled with freshly distilled water. The outlet of the vessel was connected by a glass tube filled with distilled water to a measuring burette, also filled with distilled water. The water in contact with the chalk had a very faint alkaline re-action at the beginning of the experiment, due to the presence of calcium bicarbonate. An action took place within a day or so, and a gas was generated and was collected in the measuring burette.

The wrought-iron machinings were the first to receive attention; and the period of time during which action took place was used as a basis for tests of the other specimens submitted. Analyses of the gases given off from the metals were made, and a general idea of their composition will be seen from the following average figures:

Constituents.	Volume P.Ct.
Carbon dioxide	0·00
Oxygen	1·45
Hydrogen	90·90
Methane	3·43
Nitrogen	4·22
Total	100·00

In the case of the wrought-iron machinings, the generation of gas ceased after the metal had been in contact with the chalk and water for 73 days. After the same period of time the volume of gas given off by the other metals examined was observed and compared with that given off by the wrought iron.

Below is a table showing the amount of gas given off by the action of the various metals on chalk and water in 73 days:

Metal.	C Cs. of Gas.
Wrought iron	485
High-tensile, weldless steel	8
Low-tensile, lap-welded steel	15
Mild steel	360
Cast iron	5

It is suggested that the volume of gas given off by a metal when in contact with chalk and water may be taken as an index of the relative powers of resistance of the metal to corrosion. It will be noticed that no carbon dioxide is present in the gas given off. This is probably due to its re-combination with the chalk in the presence of water forming a fresh supply of calcium bicarbonate. This action will continue so long as there is any metallic iron present.

The amount of free oxygen in the gas produced was about 1½ p.ct. by volume; the rest of the oxygen attacked the metal, forming black magnetic oxide of iron, Fe_3O_4. The formula for calcium bicarbonate may be expressed thus: $CaOCO_2\ OH_2CO_2$; and it is highly probable that the elements of water in the combination can be separated by electrolytic decomposition, due to the impurities in the metal. When the experiments were concluded the vessel in each case was opened, the contents were examined, and the aqueous portion was found to contain free ammonia in fairly large quantity, together with a small amount of sulphuretted hydrogen. The ammonia is formed by the combination of nitrogen in the atomic state being liberated from the nitrides in the metal, with atomic hydrogen derived from the elements of water in the calcium bicarbonate. In a similar manner the sulphuretted hydrogen is formed by the combination of the atomic hydrogen mentioned above with the sulphur in the metal.

Here the author would like to draw attention to the fact that frequently on exposure of an iron service pipe an odour of gas and ammonia is noticed. This is not necessarily an escape of gas from the interior, but may probably be due to the causes mentioned above.

It has been found that this form of alkaline corrosion on iron laid in earth proceeds just as rapidly as does acid corrosion on iron laid in earth.

The author has some examples of corrosion on iron pipes laid in alkaline earth—one case being in London and the other in the district of a South American gas undertaking. Another example is that of a small iron pipe fixed in the wall plaster of a London house. The plaster in the neighbourhood of the place where the hole was found in the pipe was wet, due to a leaking rain-spout. In all these cases water should not be allowed to get near the pipe. Should immunity from water not be possible the pipe should be heavily wrapped with hessian and bitumen.

With regard to the pipe in acid ground previously mentioned, similar remarks as to wrapping apply. The author has two iron pipes both heavily wrapped which were respectively buried for about twelve months in acid earth, and in chalk and water. Both pipes are still intact.

DISCUSSION.

The PRESIDENT: Mr. Taplay has here two samples of wrapped pipes that have been submitted to acid and alkaline reactions. If you pass them round, you will see that absolutely no effect has taken place at all. I am sure we are much obliged to Mr. Taplay for the large amount of work which was necessitated in the preparation of so short a report as this. I really had no idea myself, till I heard this report, that our unfortunate pipes were subjected to so many dreadful conditions, and it is only a wonder to me that they last as long as they do. As, I think, our old friend Captain Kettle used to remark, "The moral of this is in the application thereof," and the moral of this paper is clearly in either keeping our pipes free, as free as we can in all cases, from the action of water, or, alternatively, protecting them so far as we can. Mr. Taplay, who has been directly concerned with this matter of cyanogen, will say a few words to you on the subject later; but in the meantime perhaps it would be well to discuss this paper, and Mr. Taplay will speak about cyanogen when he is replying to the discussion.

Mr. J. P. LEATHER (Burnley): There are many interesting points in this paper. I was rather struck by something on the first page with regard to pipes being laid in clay soil and becoming softened to such an extent that the metal could be cut with a knife. This latter point, the report adds, was noticed by Dr. James Campbell Brown several years ago. I myself have observed it for a fair number of years—I suppose for over forty years. We certainly have a clay soil; but where we have found this action, there has generally been something other than clay about. The clay may have some effect in this way, that the clay subsoil prevents any water from leaking away and keeps the ground very damp; but I have found it, generally speaking, where it has been filled-up ground—engine ashes, and things of that kind—and we have had a good number of cases of iron pipes which could be cut with a knife, and where they were cut, the iron was almost entirely dissolved out, and the carbon left behind. One finds a difficulty in knowing exactly how this could be, and I have rather come to the conclusion (we have had various cases which we have investigated) that there is really something exceptional about the pipe as well as the position, because I cannot understand how a pipe can be as thick as it was originally, with practically nothing but carbon left, which you can scrape like a piece of very hard cheese, or something of that sort. I do not think a clay soil alone is sufficient to account for it.

The PRESIDENT: I must say this, that the phenomenon that Mr. Leather has just referred to has come within my experience at Beckton, and it has occurred in pipes which have not been so very old in point of years. But at Beckton there is a good deal of made-up ground. The bulk of the surface ground was 7 or 8 ft. below Trinity high water, and it was filled-in very largely with clinkers, and the pipes were subjected to the action of brackish water. There is no doubt this resulted in galvanic action; and, as Mr. Leather has described, we found several pipes which had the whole of the iron rusted-out of them. They were simply graphite pipes. You could cut them in the way he described; there was nothing but carbon left, and clearly there was some agent other than the clay soil which bore on this particular condition to which the pipes ultimately came.

Mr. TAPLAY: I should like to add to the President's remarks to Mr. Leather that very often clay soil will hold a lot of water. If you cannot drain it away from the cast-iron pipe, the calcium bicarbonate which is in the clay soil will do the damage mentioned. It is a question of the calcium bicarbonate in a very large number of cases. It is quite true what the President says—that brackish water will also do the same mischief. You will often find that the brackish water, with the calcium bicarbonate in the clay, together with the water which the clay holds, will do the trick. That is all I have to say with regard to corrosion. In reference to cyanogen, the Gas Light and Coke Company began their experiments in a small way for the absorption of hydrocyanic acid, knowing quite well what a vicious compound it is. We had quite a small tower-scrubber in the laboratory at Tudor Street, passing only 20 c.ft. a day; but the amount of hydrocyanic acid which I was able to use in that small tower was about eighty times as much as there is in a normal coal gas, and the results were satisfactory day by day. After I had informed our Chief Engineer, your President, of the results, he said, "Take it down on the works, and see what you can do on a larger scale." We took it down to the Gas Light and Coke Company's Bow Common station, and there we put up a plant capable of dealing with between 3000 and 5000 c.ft. a day, and I may say that the result of removing the whole of the hydrocyanic acid takes place day by day. There is about 2 lbs., reckoned as compression blow, on the gas inlet of the plant, but there is nothing to be found on the outlet. The chalk is ordinary common chalk, which we got from Grays, in Essex, and is broken-up to about the size of a hazel nut. Of course, the smaller you get the chalk, the more gas you can pass through, and up to the present time we have nothing whatever to complain about. It is removing the whole of the hydrocyanic acid and is very satisfactory.

Mr. LEATHER: Where is this scrubber? Is it after the gas is purified?

Mr. TAPLAY: No, it is on the crude gas.

Mr. LEATHER: Before the ammonia is taken out?

Mr. TAPLAY: Yes, the ammonia, hydrocyanic acid, sulphuretted hydrogen, and carbon dioxide all pass through the chalk purifier, with the result that the chalk appears to act as a sort of catalyst (although not a surface action), and the result is ammonium thiocyanate. We propose to wash the scrubber down with ordinary water occasionally, so as to present a fresh surface of the chalk to the action of the crude gas. I am hoping, by and by, to give you another little tit-bit; but I will not say at the moment what it is, because I am not quite sure of my ground. But I think I am all right.

CARBONIZATION IN HORIZONTAL RETORTS.

By GEOFFREY M. GILL, Chief Engineer of the South Metropolitan Gas Company.

The author is proposing to limit his remarks to the plant and methods employed by the South Metropolitan Gas Company; but on account of the limited amount of space which can be given to the paper, he is confining himself to some of the more important points to which special attention has been given during the past few years.

First, consideration must be given to the special requirements of the present time. These may be summarized as follows:

(1) The great need for obtaining the maximum duty from existing plant, on account of the very high cost of new plant.

(2) The necessity of carbonizing the coal to yield the highest quantity and quality of gas, coke, and liquid products.

Arising from these desiderata, there is a great need to make the coal gas of the highest quality compatible with a maximum yield of therms. This is too obvious to need any argument.

No one will gainsay the fact that, in these days of labour unrest, it is also highly important that the plant should be worked in such a manner as to reduce to a minimum laborious work, and to maintain machines, tools, and plant in good working order; for these are points which are of greater importance than is generally supposed for keeping workmen in a contented frame of mind. Besides, it has often been proved that a good accident record and a good condition of plant coincide, and *vice versâ*; and, further, it will not be disputed that "safety first" should always rank as an essential in a well-managed gas-works.

The author proposes to deal only with methods which have been found suitable for carbonizing coals from the Durham and Northumberland districts, the quality of which coals of different varieties, as purchased by the Company, is shown by the following averaged results of some hundreds of recent tests:

Moisture	2·43	
Volatile	30·21	on dry basis.
Fixed carbon	69·79	
Ash	10·86	

Correct Treatment of Coal.

In designing modern retort-house plant, there has been an overwhelming tendency to limit consideration to those machines which operate on one side only of the settings, and thereby to place certain restrictions upon the type and size of the charge of coal which can be used. Such machines, and the accompanying coal and coke handling plant, are attractive from the point of view of initial outlay and labour cost of working; but if these machines do not put into the retort the best type of charge in the best possible manner, and at least as efficiently as the more old-fashioned type of machine operating on both sides, the accompanying advantages may be too dearly bought. If consideration be given for a moment to the apportioning of the expenditure entailed in working a retort-house, it will be found that each hundred pounds will be divided approximately as follows:

Coal, £68; coke used in retort-furnaces, £13; upkeep, £9; carbonizing wages, £6; and £4 for power and incidentals. The division will, of course, vary in different works, but not sufficiently so as to obscure the argument, which is, that the matter of overwhelming importance is the best possible treatment of the coal, which bears so large a proportion of the whole expenditure. Next in importance is the reduction of fuel used, and the cost of upkeep of the plant; but this must not be at the expense of loss on coal. Carbonizing wages, to which more attention has been paid by gas engineers generally than to all the other items put together, is shown to be of relatively small importance on the expenditure side of the balance-sheet.

An Inspection System.

The author would also explain that many of the figures mentioned in this paper are based upon results obtained in periodical inspections of retort-house plant and working, extending from July, 1919, to March 31, 1921. The system provides for the reporting of all results in the form of facts and figures as opposed to opinions. Standards of efficiency are set; and the result of each examination of any particular point in the working is expressed as a percentage in relation to the standard. The inspections are of a very complete character; and in dealing with 2900 retorts, such as were in operation during the month of April, the work of carrying out one complete inspection will occupy the whole time of six inspectors for a period of six weeks. No less than 42 points are included in these inspections; and the results are recorded to show the relative position of all the retort-houses, with a summary in which all compete for a final order of merit upon the completion of each inspection. These results are posted-up in the retort-houses for all to see. The inspections have disclosed many faults, have suggested many remedies, have created interest, and have undoubtedly resulted in a steady improvement of efficiency in the running of the retort-houses.

The cost of the inspections amounts to about one-third of a penny per ton of coal carbonized.

The Design of Producers.

The producers largely used by the South Metropolitan Gas Company follow the general lines outlined in a paper read before the Gas Institute in 1888, entitled the "Principles of Gaseous Firing considered in their Application to the Heating of Retorts." These producers, two types of which are shown in figs. 1 and 2, stand out from the front of the retort-settings, and have an opening at the top (22 in. by 17 in.) into which the coke can fall as quickly as it is discharged from the retort. The feed opening, the centre of which is 9 in. in front of the face of the mouthpiece, is situated immediately over the producer; and accordingly the coke falls into its correct position without levelling. The outlet for the producer gas is placed some distance below the top of the fuel bed; and as the producers are fed at frequent intervals, usually every two hours, but never longer than four hours, the distance from the grate to the gas outlet is fairly

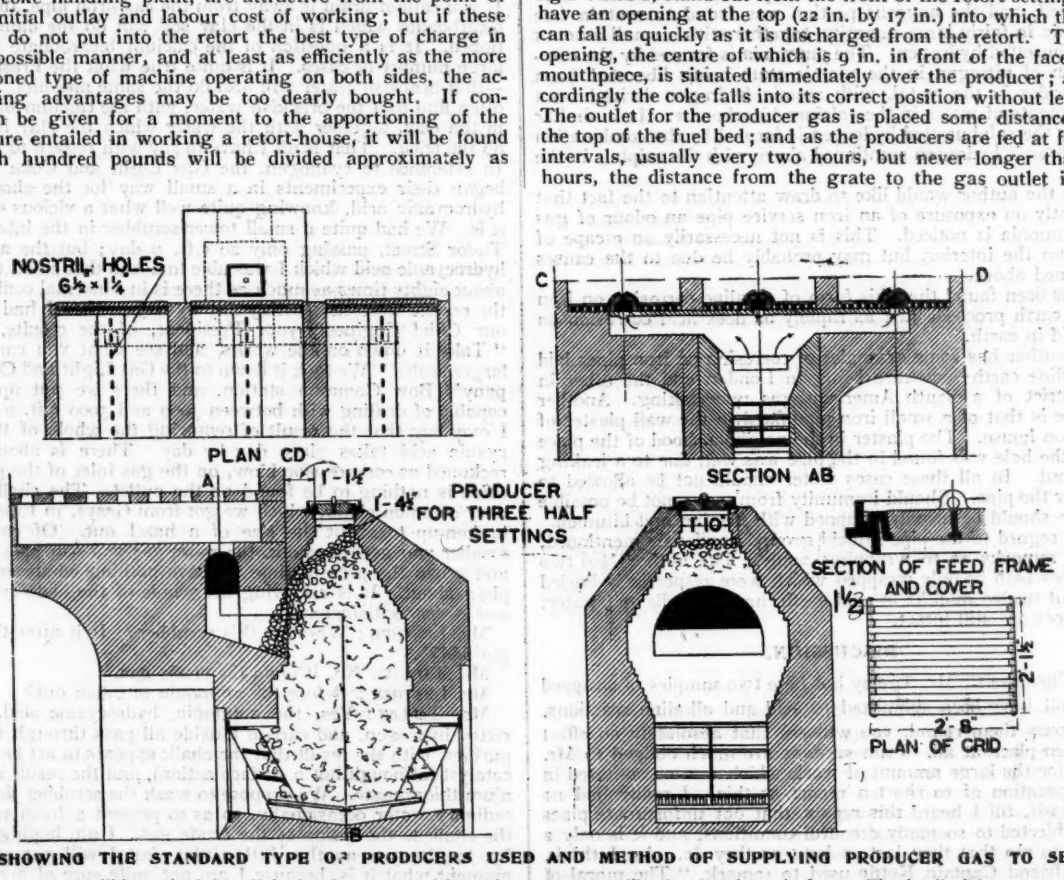


FIG 1.—SHOWING THE STANDARD TYPE OF PRODUCERS USED AND METHOD OF SUPPLYING PRODUCER GAS TO SETTINGS.

It will be noticed that clinkering doors are at right angles to retorts, unlike the type shown in fig. 2. The detail of the sand-sealed producer lid will also be noticed.

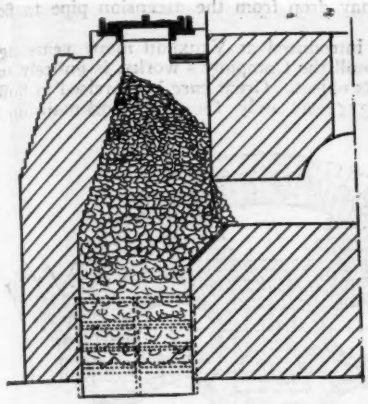
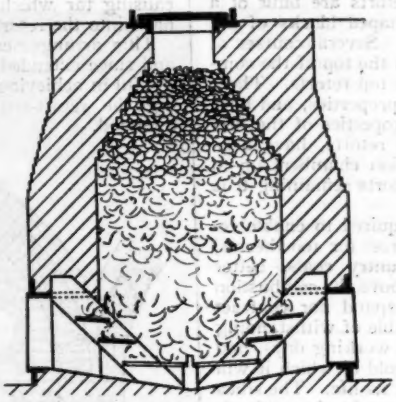


Fig. 2.—Producer with Basket Type of Grate and Clinkering Doors Parallel with the Retorts.



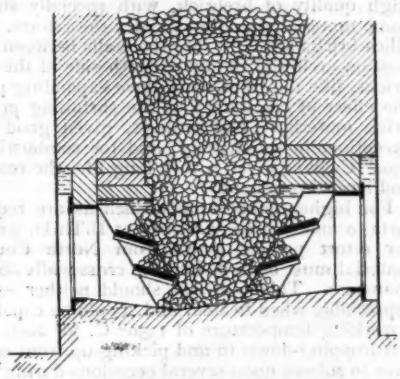


Fig. 3.—First Type of Double-Grate Producer.

constant, and results in a good quality of producer gas being made. These producers have been designed to heat two, three, or four half-settings of ten retorts each, and are practically identical with those installed at Vauxhall over thirty years ago.

This design of producer is a very good one, and is a great improvement upon those of a long and narrow shape which are built in the limited space between the two rows of regenerators in the usual design of retort-settings. In the author's opinion, not nearly enough attention has been given to the proper design of producer for retort-settings, the producers being frequently poked into the only remaining space after the retorts and regenerators have been dealt with. The producer is in reality one, if not the most, important factor in obtaining good results from a setting.

The feed openings of the producers have cast-iron frames, in which a groove is cast for sand; and into this the cover is bedded, the joint thereby made being to all intents and purposes air-tight. Far too little attention is paid, as a general rule, to the maintenance of tight feed openings to producers; and much damage and waste of fuel can be traced to this cause, whereby the top of the producer is converted into a combustion chamber, without, however, being adapted to stand the high temperature thereby generated.

The clinkering doors of producers, as usually constructed, are rarely, if ever, air-tight, even when new; while there is always a tendency for the doors to warp. It is obvious that there is no object in carefully regulating the primary air slides if at the same time a quantity of air can find its way through the space caused by ill-fitting doors, which space cannot be computed. To provide against such leaks, dovetailed grooves have been machined in the doors, and into these packing is placed; the joint itself being made by the packing and the machined face on the frame.

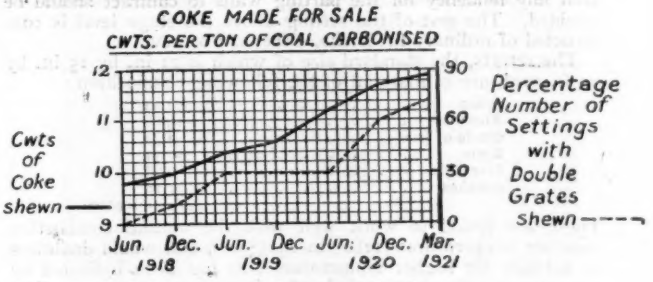
The Grate Area of Producers.

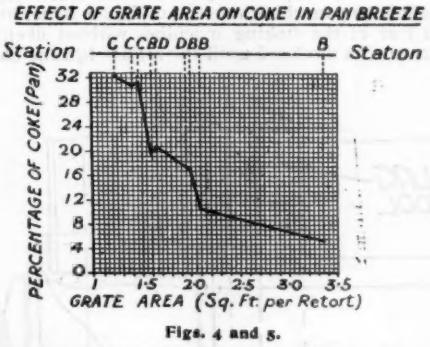
The importance of sufficient grate area is not always appreciated; and the results of some work carried out in the South Metropolitan works in this connection will not be without interest. The amount of grate area (step grates) in the various works was, until recently, from 1·2 to 1·5 sq. ft. per 20 ft. retort; and it is probable that the average of about 1·35 sq. ft. is not out of accord with gas-works generally. Some experiments were made early in 1919 to determine the effect of substantially increasing the grate area; and this was done by building two step grates instead of one as formerly to the bottom of the producers, as shown in fig. 3. This was entirely successful from all points of view; and it resulted in saving of fuel, furnace bars, furnace linings, and labour, while it improved the working of the producers—the quality of the producer gas being better and more uniform, while the capacity of the producers was increased. This is no small advantage with the coke from bad coal, in using which we have all become expert.

A further improvement was made in this type of grate by connecting the two bottom steps on each side of the furnace by a grating, as shown in figs. 1 and 2. By this means, the whole of the grate area is maintained in a lively condition, and air has ready access to the entire grate; whereas with the fuel resting upon the ash pan itself, there is a tendency for a dead fire to be formed at the point furthest from the air inlets. Water is used to cool the step plates, but only so much as will evaporate; none being allowed to accumulate at the bottom of the furnace—the ash-pits being in all cases dry, though drains are fitted to provide for any water that might accumulate.

At the works where this type of grate—which is known as the basket grate—has been used most largely, and for the longest time, the results of coke made for sale are interesting. In fig. 4 is shown the improvement in the amount of coke made for sale as the proportion of this type of grate has been increased. In arriving at the coke made for sale, it is the practice of the South Metropolitan Company to include with coke used in the retort-houses all coke used in boiler-houses, lobbies, cranes, locos., sulphur plants, and for any other gas-making purposes. The figures are therefore prejudiced, if compared with others where coke consumption of this sort is assumed to be a sale, as is done in some cases. In this connection, it should also be mentioned that the coke breeze is purposely kept of a coarse character, in order to provide the boilers with sufficiently good fuel to maintain regular steam pressures.

It may be asked in what manner the type of grate and the area affects the consumption of fuel. The reduction in fuel used is chiefly due to the reduction in pan breeze made, and in the quantity of coke—or combustible fuel—in the pan breeze. In retort-house inspections it is the practice to sample the pan breeze, and ascertain the amount of coke present. This is done by screening the pan breeze through a 1 in. square mesh sieve, and by hand-picking the coarse material left in the sieve. With these grates in use, a great change is made in the character of the pan breeze; the actual coke present being reduced from about 25 to 10 p.ct., or a similar result to that found in boiler





Figs. 4 and 5.

NOTE.—The grate area is the total superficial area of the grate, without deduction for the space occupied by fire-bars, &c.

ashes, rendering it unworthy of treatment in pan breeze washing plant. The saving in other directions is due to a reduction of clinker and an increase in ash dust, which is in itself an indication of a lower temperature and the cause of a saving in firebars and furnace linings. In practice, it is found that the temperature in the hottest zone above the grate is in the neighbourhood of 1200° C. In fig. 5 the relationship between grate area and the quantity of coke lost in pan breeze is shown; this curve being based upon a number of examinations of the pan breeze from furnaces with varying grate areas.

The Design of Retort-Settings.

The design and construction of the standard setting of ten retorts in general use by the Company has been greatly improved since the idea of using retorts set in tiers of five was adapted from the practice of the Imperial Gas Company a good many years ago.

The design provides for a Gothic combustion arch of silica

material. The cross-walls between the retorts are built of a high quality of firebrick, with specially shaped blocks of the same material round and under the retorts. Several courses of silica bricks are built into the walls between the top of the combustion arch and the underneath side of the top retorts. These bricks, like the silica arch, have expanding properties, and have the effect of counteracting the shrinking properties of the firebrick material. The settings, given good retorts, have been exceptionally satisfactory, and for combustion chambers up to 1300° C. have given a very long life, the retorts remaining true and level throughout.

For higher temperatures, such as are required to enable retorts to make 18,000 c.ft. of 555 B.Th.U. gross (or 100 therms) per retort per 24 hours from North Country coals, better material must be built into the cross-walls above the combustion chambers. This material should neither expand nor contract appreciably when heated, and should be capable of withstanding a working temperature of 1350° C. for 2000 working days, and the dropping-down to and picking-up from cold to which it will have to submit upon several occasions during its life. The silica content of such material as found satisfactory in the author's works varies from 86 to 92 p.ct.; while its cost is by no means prohibitive to the building of retort-settings.

The producer arch is also constructed of the same quality of material; but the secondary air flues above the producer arch are built of silica bricks containing the same percentage of silica as the combustion arch itself. The cross-walls, including the joint walls, are 4½ in. in thickness; while the space between the walls is 9¾ in. The cross-walls are continued to the top of the arch, with the exception of the space immediately under the centre of the main arch. A fundamental principle of the design has been the reduction so far as possible of the amount of retort-heating surface covered by the cross-walls; and for many years only 41 p.ct. of the outside surface of the retorts from end to end have been covered by brickwork, while in no case is any form of protecting block used. This design has been completely successful. The main arch of the setting is constructed of the same material as used in the cross-walls between the retorts; the lower ring being of 9 in. bull heads. It is proposed to build the parting walls of like material, though this has not hitherto been done; but it is thought that the long life of these parting walls justifies the use of a better-class material, while it is essential that any tendency for the parting walls to contract should be avoided. The rest of the setting above the stage level is constructed of ordinary firebricks, either old or new.

The retorts, the standard size of which is 21 in. by 15 in. by 20 ft. oval, are of material of the following composition:

Silica	77·42
Alumina	19·66
Oxide of iron	1·32
Lime	0·34
Magnesia	0·08
Alkalies	1·18
	100·00

These are found to work well with the normal combustion chamber temperatures (1280° to 1325° C.), and would doubtless be suitable for higher temperatures, as has been indicated by experiments over short periods of a few weeks at a time. The retorts, which are machine made, are found to withstand the wear and tear of the stoking machines without ill-effects, nor are surface cracks disclosed until the retorts become old.

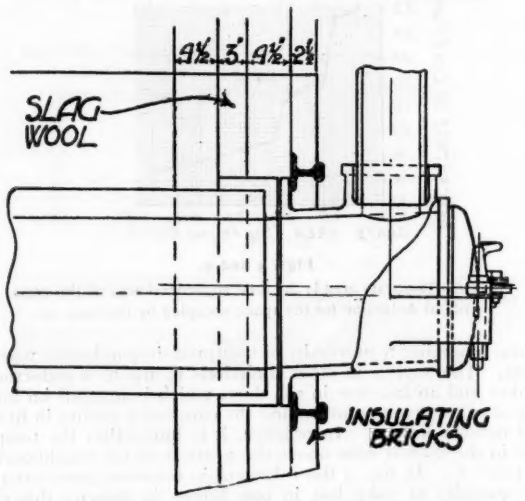


Fig. 6.—Showing Standard Method of Constructing Front Wall with Double Thickness of Insulation and Retort Mouthpiece with Fall into Retort.

The front wall is built as shown in fig. 6, from which it will be noticed that there are two heat insulation thicknesses. The retorts have plain ends over which iron sockets are placed; these being built into the front wall. To the sockets the retort mouthpieces are bolted; these being constructed to provide a ¾-in. fall from the face of the mouthpiece to its flange, for the purpose of causing tar which may drop from the ascension pipe to flow back into the retort.

This arrangement introduced at Vauxhall many years ago, and since extended to all the Company's works, is entirely successful in achieving its object. Great care is exercised in building the retort-settings; and only the best workmanship is tolerated.

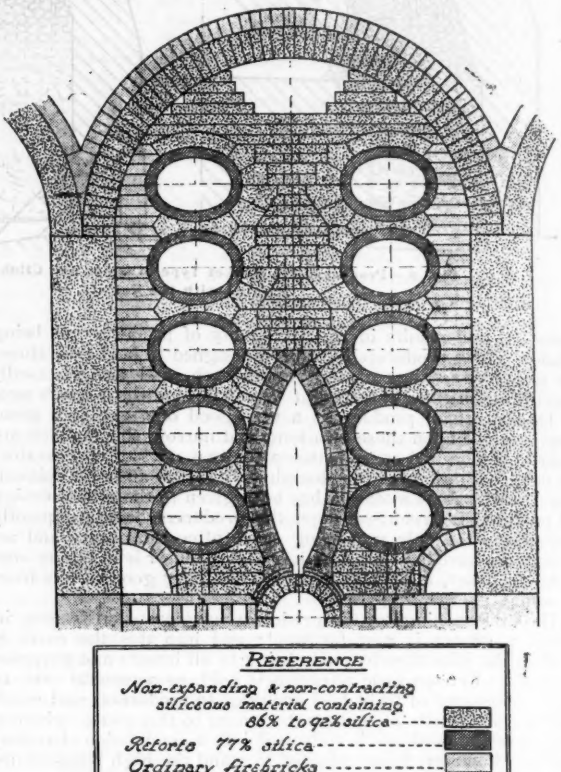


Fig. 7.—Showing Class of Refractory Materials used in Standard Retort-Setting.

A front elevation of the standard design of retort-setting is shown in fig. 7.

The Working Life of Retorts.

It may be interesting to state the working lives of all the retorts which have been pulled out during the past ten years, with the estimated amount of coal carbonized per retort life:

	Working Life in Days.	Coal Carbonized per Retort in Tons.
1912	1245	1469
1913	1404	1615
1914	1363	1525
1915	1511	1647
1916	1389	1500
1917	1412	1553
1918	1659	1858
1919	2007	2288
1920	1948	2281
1921	1549	1859

Having had considerable experience of the use of German retorts, it will not be without interest to give the record of such of these retorts as have been pulled out. Two thousand German retorts have been pulled out, the average working life having amounted to 1873 days; while 250 of these retorts are still in use.

The Need for Higher Quality of Materials.

As an instance of the disastrous effects of contraction of the material supporting the retorts, there is shown in fig. 8 a view of one setting of a range of twelve, in which many of the blocks round the retorts had each contracted no less than ¾ in., thus causing the complete and premature failure of the settings. In fig. 9 the setting as originally constructed is shown; and in fig. 10 the actual amount of shrinkage of the blocks is seen in more detail, the blocks (shown white) being the final size when pulled out, while the amount of shrinkage since the blocks were new is indicated by the part shown black.

The author has no hesitation in asserting that better materials than those in general use must be found, if good results are to be obtained. Far too little is known of the capabilities of the various materials used in retort-settings. The makers generally cannot supply this information. Gas engineers are naturally unwilling to experiment, at great risk and cost, to prove such and such material. Even were they to do so, it is probable that the next consignment would be of a different character. Gas engineers are not free from blame; and far too little use is made

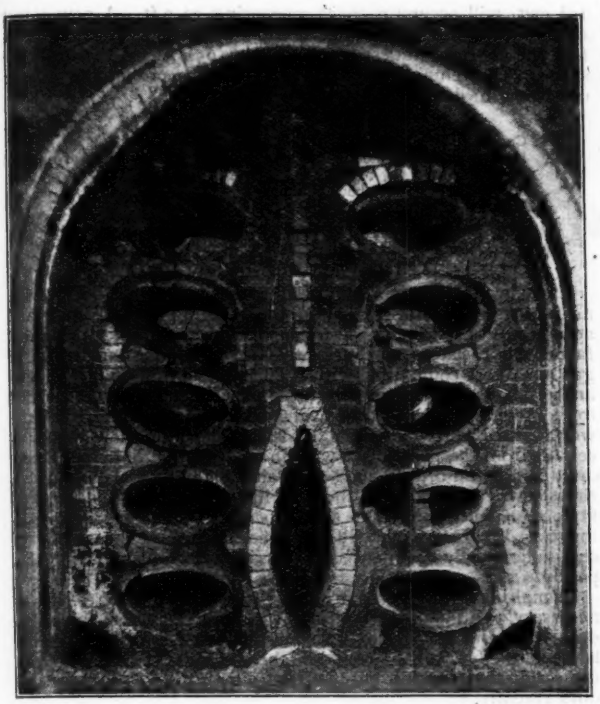


Fig. 8.—Showing the Effect of Using Materials which Contract in Working. This should be Carefully Compared with fig. 9.

of the pyrometer for watching and checking combustion chamber temperatures. This practice is, besides, of great assistance in maintaining heats and in quickly disclosing that something is amiss with a setting before the actual temperature of the retorts is seriously affected.

THE USE OF UNBURNT MATERIAL IN BUILDING RETORT-SETTINGS.

An interesting and successful experiment has been carried out in one setting in which the cross-walls from the stage level and upwards have been built of a mixture of unburnt clay and grog; the composition being such that, when burnt, a slight expansion will take place. The clay was applied in a stiff plastic form; ordinary burnt material only being used for the combustion arch, the retorts, with a few supporting blocks at intervals of 5 ft. apart, and the outside half of the front walls. After completion, the setting was dried and heated in the usual manner; the unburnt material being fired as in a kiln. The setting has been at work for 24 weeks, during eleven weeks of which the

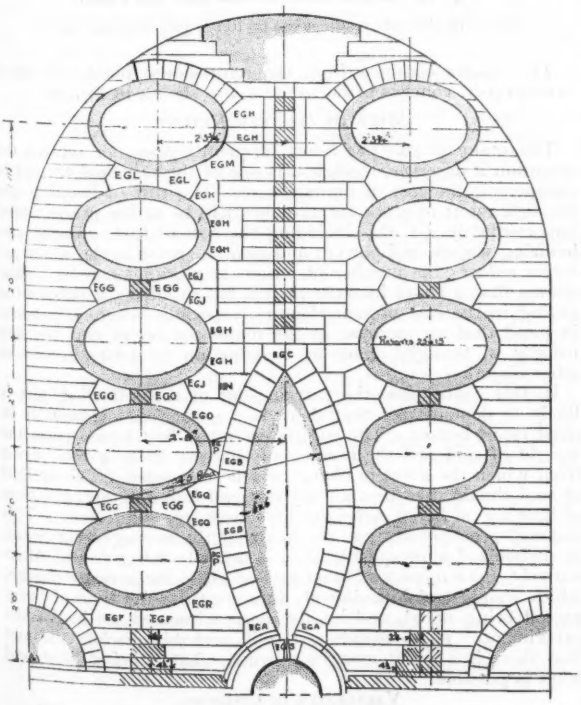


Fig. 9.—Showing the Original Construction of the Old Setting Illustrated in fig. 8.

combustion chamber was worked at a temperature of 1400° C., which allowed of the complete carbonization of the ordinary ten-hour charges in eight hours. No signs of failure have as yet been detected. The advantages of this method of construction are obvious.

RETORT PIPES, MOUTHPIECES, AND LIDS.

Each retort is fitted with two 5½ in. ascension pipes; great importance being attached to the provision of two pipes for each retort. The bends are made as easy as possible, their various radii measuring 3 ft., 3 ft. 5 in., and 3 ft. 7⅛ in. respectively.

In the South Metropolitan works, great care has been taken to maintain mouthpieces and lids in as tight a condition as possible. With this object in view, the mouthpieces are faced

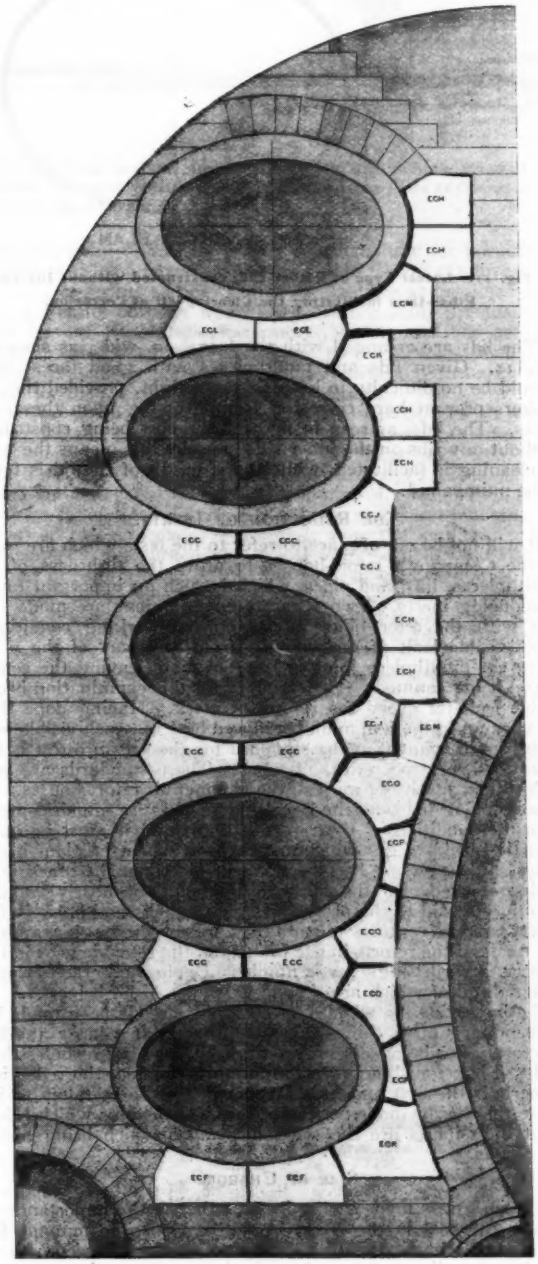


Fig. 10.—Showing the Actual Amount of Shrinkage which Occurred in the Case of Each Block Used in the Setting Shown in figs. 8 and 9. The White shows the Final Size of Block, and the Black the Amount of Contraction from the Original Size.

whenever this is necessary; and for this purpose careful examination is made at the time retorts are renewed. The face of a mouthpiece will frequently last in good condition for several years; but it has been the usual custom to face them whenever the retorts are renewed.

The mouthpieces have been faced upon a variety of machines in the Company's works; a boring mill being probably the most suitable. Portable facing machines have been used with success for facing mouthpieces *in situ*; while the same machine has been used for carrying out this operation upon mouthpieces as removed from the retorts upon renewal, the work being done in

the retort-house. For works of moderate size, such a machine should suit the purpose admirably. For facing lids, special machines are in use in the South Metropolitan works; but in small works this can be carried out quite well with hammer, chisel, file, and surface plate.

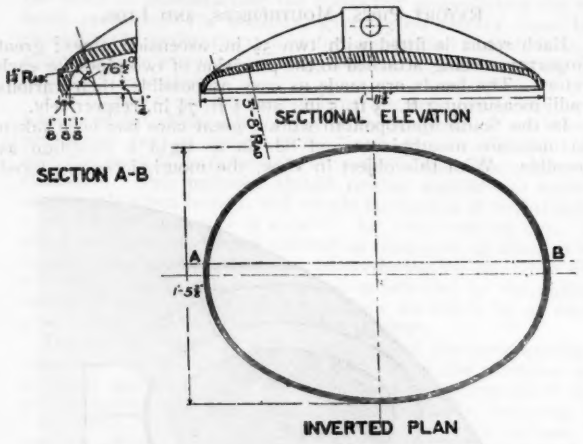


Fig. 11.—Latest Type of Retort-Lid, constructed without internal Ribs—thus facilitating the Clearing-off of Corrosion.

The lids are arranged with the face $\frac{1}{8}$ in. wide, as shown in fig. 11. Given lids and mouthpieces with good faces, there should be no difficulty in keeping them tight, provided that the stokers prevent hard corrosion from growing upon these surfaces. The lids, as seen in fig. 11, are now being constructed without any ribs on the inner side; and by this means the work of cleaning is facilitated, while the strength of the lid is found to be unimpaired.

The Reduction of Inerts.

It will not be out of place to refer to the tests which are made in the Company's retort-houses to prove the tightness of the mouthpieces, lids, and pipes, which is such an important factor in reducing inerts. Two separate examinations are made—the first with the retort-house under normal working conditions, every visible leak of gas coming from any part of the plant (from the mouthpiece joint to the foul main leaving the retort-house) being counted. The standard for this examination is one visible leak for every 100 retorts at work. Having done this, the vacuum in the foul main is reduced by $\frac{1}{2}$ in., each visible leak being again counted. The standard for the pressure test is ten leaks for every 100 retorts at work. These standards are well within the capacity of most of the Company's retort-houses.

In reducing inerts to the lowest possible figure, much depends upon the condition of the retort-fittings; and it must be quite clear that leaks of gas which are disclosed when the plant is put under slight pressure become leaks of air when the pressure is again removed. In the author's opinion, not nearly enough attention is paid to the prompt repair of cracks and holes in the retorts; and he ventures to state that, were a thorough examination made of the retorts in use in most of the retort-houses in the country, a surprisingly large number of holes and cracks would be found, all of which are a potential cause of high inerts.

The inspections to which reference has already been made include, among other things, the examination of a large number of retorts after being discharged; and the number of holes thus disclosed is astonishing. In the author's opinion, the reduction of inerts is the first and most important step to be taken to increase the therms made per ton of coal. The causes which bring about high inerts are the self-same causes which bring about loss of gas.

Size of Charge.

Reference was made earlier in the paper to the importance of placing the coal in the retort in the best possible manner for obtaining the highest quality and quantity of gas and products.

It is an undisputed fact that the heavy charge has a great advantage in these respects. Engineers generally will not forget the substantial improvement which was effected in the working conditions when a change was made from light to heavy charges some eleven or twelve years ago. Therefore, apart altogether from the mechanical excellence of stoking machines; and from the cheapness with which these can be operated, it seems essential that the machine to be used must be one that will put in the best charge from a carbonizing, as distinct from a labour-saving, point of view.

It is assumed that the best charge is the heavy charge, which the author would venture to define as one that will occupy approximately two-thirds of the space in a new retort when first charged. The South Metropolitan retorts are mostly of a 21 in. by 15 in. oval section, by 20 ft. long, and are charged with an average of 10$\frac{1}{2}$ cwt. of coal for ten hours. Assuming that a ton of coal, when broken, measures 42 c.ft., the above charge of 10$\frac{1}{2}$ cwt. will occupy a space measuring 22 c.ft. A new retort of the above dimensions has a capacity of 34 c.ft., and therefore the charge in question will occupy 65 p.ct. of the available space. The remaining 35 p.ct. is utilized approximately as set out below in detail:

	Per Cent.
Coal	65·0
Its expansion when coked	8·0 (= 12 p.ct. of charge)
Space for scurf	14·0
Gas passage—2 in. above charge	6·0
Balance	7·0
	100·0

Duration of Charge.

Early in 1916, as the result of an extension of munition works, an increase was anticipated in the consumption of gas; and accordingly experiments were made to determine the most favourable duration of charge to yield the maximum make of gas per retort compatible with the best yield and quality of gas and products. Following on these experiments, it was decided to work ten-hour instead of twelve-hour charges at three of the works fitted with horizontal retorts. The alteration was successful from the point of view of increasing the make per retort and the amount of coke made for sale per ton of coal carbonized, though whether it caused the drop in the make of gas, tar, and liquor per ton of coal which was experienced during the succeeding two or three years, will never be known, as the quality of coal undoubtedly commenced to deteriorate seriously during this period.

In making a change from twelve to ten hour charges, it was necessary to tune-up the settings, producers, and machines, to deal with and carbonize the additional coal. This could not be done so effectually as would be the case in normal times, with the result that the full effect of the alteration was not realized until recently.

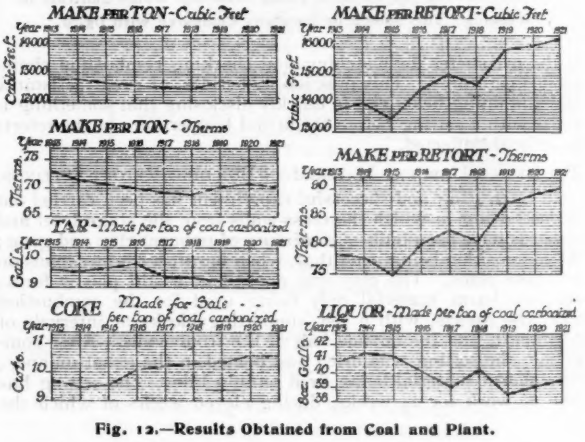

MAKE PER TON - Cubic Feet
MAKE PER RETORT - Cubic Feet
MAKE PER TON - Therms
MAKE PER RETORT - Therms
TAR - Made per ton of coal carbonized
COKE Made for Sale per ton of coal carbonized
LIQUOR - Made per ton of coal carbonized

Fig. 12.—Results Obtained from Coal and Plant.

[Note that the 1921 readings are up to the 31st of March only.]

The results obtained from the retort-house plant, of which over 90 p.ct. consists of horizontals, are shown in fig. 12.

Make of Gas per Retort.

The make of gas per retort frequently does not receive the attention it deserves, though it is one of the principal factors in cheapening the cost of manufacture. The cost of keeping one through retort at work for 24 hours will be at the present time approximately £1, this including the cost of fuel, upkeep, carbonizing wages, and power; and as an increase in the make per retort reduces the number of retorts at work, it can be readily shown that a small increase in this figure effects a substantial saving in the cost of manufacture, especially when it is borne in mind that an increase in the make per retort can be, and usually is, brought about by a reduction in waste in one or other direction.

In this connection, the carrying-out of the following test is likely to demonstrate that there is a great loss of capacity in most retort-houses. The suggested test is first to ascertain the weight of coal and the number of charges in a given period from which the average charge can be computed. This weight of coal should then be carefully charged into a retort; the time of burning-off being noted, and its discharge witnessed. This test will probably disclose the fact that the average charge can be carbonized more quickly than is actually being done. Alternatively, 10 or more p.ct. should be added to the average charge, which should be laid uniformly into a retort; the time of burning-off being noted, and its discharge witnessed, as in the last experiment. These simple tests will probably disclose the fact that there is a great margin between what is being done and what is possible.

Variations in Charges.

It is not generally recognized how great are the variations in the size of charges in different retorts in any one retort-house.

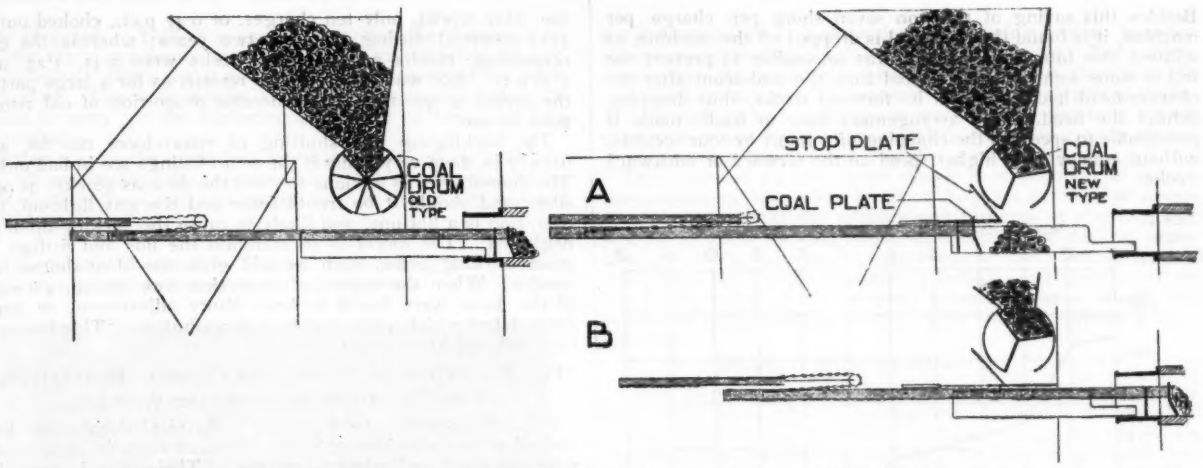


Fig. 13.—Showing the Latest Method of Obtaining an Equal Fall of Coal at Each Drop, and the Means whereby the Coal may be Dropped upon a Receiving Plate prior to the Return of the Charger Head, thus Saving Time and Waste. The Coal or Receiving Plate is Operated by a small Constant Pressure Ram and the Charger Head.

To the eye, the charges may appear uniform, both when lying as coke in the retort and when discharged; but if the driver be asked to drop a number of charges in the passage, and if each be weighed, it will probably be found that an astonishing variation, amounting to over 20 p.ct. from maximum to minimum, will be shown in the results. This, at least, has been demonstrated by the author's experience of many hundreds of charges weighed in this manner, chiefly from Arrol-Foulis machines, and to a smaller extent from West's scoop machines, which, however, work to a closer variation—usually from 14 to 4 p.ct. If these machines show these large variations, it is probable that other types of charging machines give equally discordant results when worked in everyday practice in retort-houses.

With the object of reducing the variations in the case of the Arrol-Foulis machines, the coal drum, which acts as the feeding and measuring device, has been re-designed, the alteration being shown in fig. 13. This has greatly improved the working of those machines to which it has been fitted; and on these the normal variations do not amount to more than 10 p.ct.

With the Arrol machine, the speed of charging was found to be an important factor in reducing variations. If the coal feed be regulated with a given speed of charging, and this speed be maintained, there will be a normal variation; but if the speed be altered, the amount of coal charged into the retort will vary as the result of the alteration. This will be readily understood, if due consideration be given to the charging mechanism of the machine; for the pusher-head in its forward motion will leave a varying proportion of the coal behind it if the speed be too great or too small, while it takes a certain amount of speed to provide the necessary impetus to place the coal in its proper position. As a consequence, the constancy of the pressure supply to the machines is a matter of importance; but this will vary substantially with the load, unless special attention be paid to the lay-out of the pressure pipes and the size and position of the accumulators.

Another cause of variations in the weight of charges is due to the size of coal from the breakers, the general design of which is not suitable for breaking coal to a uniform and small size. The standard adopted by the Company provides for 97 p.ct. of the coal to pass through a 2 in. square mesh. Before this standard was adopted, it was found that over 10 p.ct. of the broken coal was too large to pass through this size of screen; and undoubtedly these lumps were one of the causes of the irregular working of the machines.

Stoking machines are not adapted for working with large coal; and improvement may be expected to result from the elimination of these lumps. Besides, irregularity in the size of coal causes variations in the weight of coal contained in the measuring devices, the size of which is based upon cubic capacity. It has been found that the ordinary type of breaker is not very suitable for crushing coal to the small size which it is suggested is necessary for the regular working of machines; and some success has been attained with a breaker of the type shown in fig. 14.

With the Arrol-Foulis charger a further cause of variations in the weight of charges is the size of the charger-head, which size should be maintained within a small margin of variation. Should the head be allowed to wear unduly before changing, the amount of coal left behind on each forward stroke will be increased. To prevent this, maximum and minimum templates have been cut, and heads in use are checked against these templates; the amount of wear being limited to $\frac{1}{2}$ in. in height and $\frac{1}{4}$ in. in width. This also comes within the purview of the inspection system.

Speed of Working.

With long retort-houses, frequently with one set of machines, it was recognized that speed of working was very important from the point of view of giving sufficient time for keeping the machines in repair, and for working with the maximum amount of vacuum on the settings for as long a time as possible, which can generally be done when all doors are shut, provided—and this is very important—that retorts, pipes, and lids are kept tight. Speed is also an advantage to the stokers, while considerable benefits are derived from retorts and furnaces being open for the shortest possible space of time.

To cut-down the length of draws, it was decided to run the chargers and pushers at their maximum speed consistent with due consideration being given to the wear and tear of the machines. It was considered, after prolonged trials, that the most suitable speed for putting a charge of 5¼ to 5½ cwt. of coal into 10 ft. of retort in seven shots with the Arrol machine, was from 28 to 32 seconds; and this is now the standard. Some machines were worked at a speed of 25 seconds; but this was found to be detrimental from the point of view of upkeep of the machines.

The pushers also have been regulated to do the outward stroke in 17 seconds and the backward stroke in 11 seconds, or a total of 28 seconds. Considerable improvement can be shown on these speeds; and, in fact, at one works the corresponding times are 15 seconds, 8 seconds, and 23 seconds respectively. But in these cases the pushers are working in conjunction with West's scoop chargers, which place a charge in a retort at the comparatively fast speed of 22 seconds.

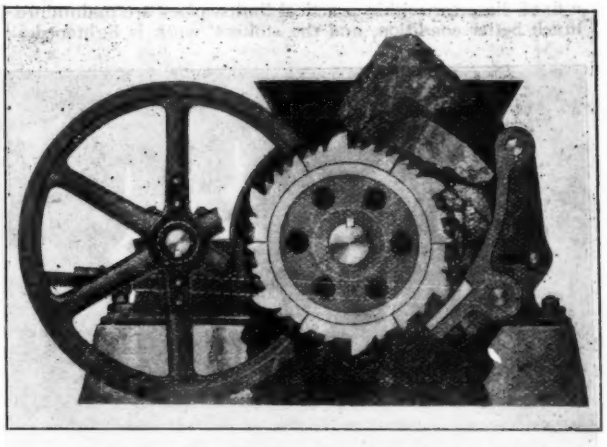


Fig. 14.—A Single-Roll Coal Breaker Adapted for Breaking Coal to a Small and Uniform Size.

As the result of speeding-up the machines, the draws are done more quickly, the standard time being 65 seconds per retort charged; but it is found that, to attain this speed with any certainty, the retorts must be in moderately good condition. At one works this question of speed has been tackled with particular success, as shown by the diagram, fig. 15.

On the Arrol-Foulis charger another improvement (shown in fig. 13 A and B) has been introduced in the shape of a plate interposed between the coal-drum and the coal-pan. By this means, the coal to be pushed into the retort is ready to be dropped in front of the charger-head simultaneously with its arrival at the extreme end of the backward stroke; and, in this way, the time necessary to move the coal-drum after the charger-head has reached the starting end of its stroke is saved.

Besides this saving of time on seven shots per charge per machine, it is found that less coal is dropped off the machine, as without this interposed plate it was impossible to prevent the fall of some small amount of coal from the coal-drum after the charger-head had started on its forward stroke, thus dropping behind the head. This arrangement has, in itself, made it practicable to speed-up the charging of a retort by four seconds, without employing a higher speed on the forward or backward stroke.

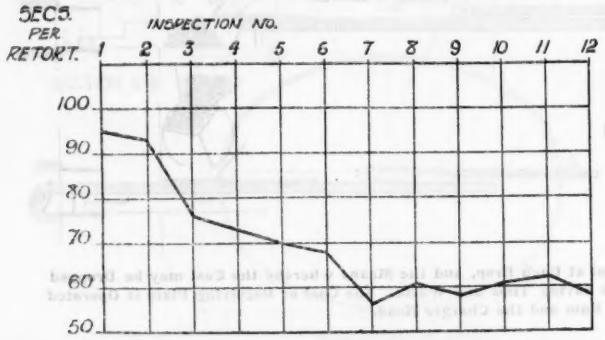


Fig. 15.—Showing the Progress Made at One Station in Shortening the Draws. There is an Interval of from One to Two Months between Each Inspection.

Speed of working is not dependent only upon the speed of the machines, though this is the chief factor. Freedom from stopped or hard pipes, the ease with which furnaces can be filled and retorts discharged, and, to a lesser extent, the readiness with which the doors can be shut, are all contributory causes.

With heavy charges, there should not be much trouble with stopped or hard pipes if the hydraulic mains are kept free from accumulations of partially distilled tar, and if the pipes are properly cleared with augers. In the author's works, standard sizes of augers have been fixed for each retort-house; and these are daily tried with gauges. With 5½-in. pipes, the new augers are made of 5⅜ in. diameter, and are returned to the shop when this has been reduced to 4⅞ in. The augers are made as shown in fig. 16; and, being open in the centre, the smith is enabled to enlarge them until the metal has been worn down to a considerable extent. There is no doubt that, by keeping the augers to a fixed diameter within practical limits, pipes are maintained in much better condition, and the stokers' work is lightened.

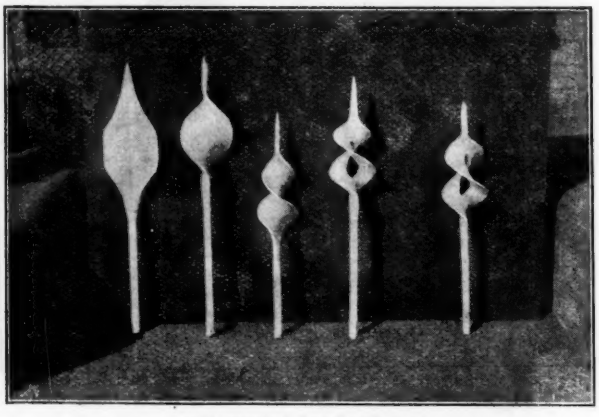


Fig. 16.—Showing Stages in Making Augers.

The type of auger rod is of importance. This should be light, flexible, and free from a tendency to kink. Special steel ¾ in. in diameter, and suitable for the purpose, is used—its flexibility being all-important.

The speed of filling furnaces can be accelerated, provided that the design of the producer is substantially as described earlier in this paper. In ordinary working, a retort is discharged into a producer in about 1¼ minutes from the time the lid is lifted off until it is again replaced. Seeing that these producers feed three or four half-settings, not much time is lost in filling them.

Failure to discharge a retort can be a fruitful cause of loss of time. This is due to well-known reasons—such as newly-scurfed retorts, bad retorts, badly burnt-off charges, but more often than all to badly laid charges, this resulting in a charge of coke which has not the requisite degree of strength to hold together while the pusher is exerting pressure upon the end of the charge. Well-laid charges rarely, if ever, choke in the retorts, as shown by the fact that at one of the author's works where the charges are undoubtedly better laid than at any of the other works, only ten charges, or 0·47 p.ct., choked out of 2112 observed during the past two years; whereas the corresponding results at the other works were 2·41, 1·23, and 1·36 p.ct. Nor was it due to new retorts, as for a large part of the period in question a considerable proportion of old retorts were in use.

The backing-up and shutting of retort-doors can be, and usually is, done very badly if the retort-fittings are in bad order. The door-shutter is anxious to close the door as quickly as possible; and should it be troublesome and the gas light-up, the operation is a hot one, and likely to cause the backing-up to be neglected. The moral is to maintain the lids and fittings in good working order, such as will give the door-shutter no trouble. When the system of inspection was started, 4·6 p.ct. of the doors were found to have faulty adjustment, or some other defect which gave trouble to door-shutters. This has now been reduced to 1·2 p.ct.

The Regulation of Combustion Chamber Temperatures, and the Quality of Producer and Waste Gas.

For this purpose, the Company's chemical department has trained a number of retort-house testers to work in close touch with the chief carbonizing foreman. Their time is spent in observing combustion chamber temperatures, and in testing the producer and waste gases of the settings, and especially of those which are not working satisfactorily. With their assistance, the heating of the settings has become more uniform, and the efficiency of combustion has been improved; the fuel being used to greater advantage.

The author considers that it is a paying proposition to employ a trained retort-house tester solely to assist in regulating the settings in any retort-house containing more than 150 retorts; while in smaller works these duties could doubtless be combined with tests outside the retort-houses. The standard of efficiency in the case of the South Metropolitan Gas Company is based upon a percentage of over 18 p.ct. of CO_2 in the waste gas, and over 25 p.ct. of CO in the producer gas—both reasonable figures, which are expected and obtained in 75 p.ct. of the tests made.

Considerable importance attaches to the maintenance of adequate and uniform temperatures in the combustion chambers of retort-settings. In the author's works, daily temperatures are taken of the combustion chambers in each retort-setting; and all are maintained as nearly as possible between a minimum of 1280° C. and a maximum of 1325° C. The Wedge Pyrometer, made by the Wedge Optical Instrument Syndicate, is used for this purpose; and these are calibrated periodically in the physical laboratory.

Much importance is attached to the taking of the temperatures in combustion chambers as opposed to retorts, the temperature of which vary from minute to minute, according to sundry extraneous circumstances. It has been found in practice that a comparatively small difference in combustion chamber temperature makes a great difference in the amount of coal which can be carbonized in a given time. For instance, with 10½ cwt. charges, an average combustion chamber temperature of 1270° C. is found sufficient to carbonize this size of charge completely in twelve hours. To carbonize it in ten hours, the temperature must be increased to 1310°; while to carbonize it in eight hours, the temperature must be increased to 1400° C. These are merely approximate figures, to illustrate the point in question.

Make of Coke for Sale.

The author does not propose to deal with any system of regeneration. He would, however, draw attention to the influence of the quantity of coal carbonized per retort per day upon the quantity of coke made for sale per ton of coal carbonized. If a high output is being obtained from the retorts, the coke required for heating the retorts is likely to be reduced per ton of coal carbonized. This at least is the experience of the South Metropolitan works, as shown in fig. 12.

In another part of this paper, the question of variations in charges is discussed; and there is little doubt that coal which should have been charged into a retort, but which is omitted through some faulty working, could have been carbonized without the consumption of any additional fuel, and in like manner the omission of the coal would have a direct bearing upon the amount of gas made per retort. In the author's opinion, the efficiency with which the work is done, and the coke gasified in the producers, is a much greater factor in increasing the amount of coke available for sale than is the adoption and working of the best type of regenerators, important though this may be. The efficient regulation of the quality of producer and waste gases, and the maintenance of steady combustion chamber temperatures, as dealt with elsewhere, are matters which closely affect this question. He would therefore urge that, in order to increase the amount of coke made for sale, very great importance attaches to the efficiency of the general working of the plant.

Stokers' Tools.

Much care has been taken to design the best type of stokers' tools. The days of the heavy spud-bar have gone; and whereas this tool with the old type of grate weighed ½ cwt., this has now been reduced to less than ¼ cwt. for use with the latest

type of grate. This is a great gain; and the difference in weight fairly represents the reduction in the laborious nature of the work. Much use is now made of the combined bar hook and spud. This only weighs 20 lbs., and is usually quite sufficient to carry out the clinkering operations on the latest type of producer.

Reference may be made to a new device (fig. 17) used for lifting off and holding the producer lids. This is attached to the side of the pushers, and enables the lid to be moved and replaced with ease and speed.

SUNDAY WORKING.

The South Metropolitan method of working the furnaces while the plant is shut down on Sundays may not be without

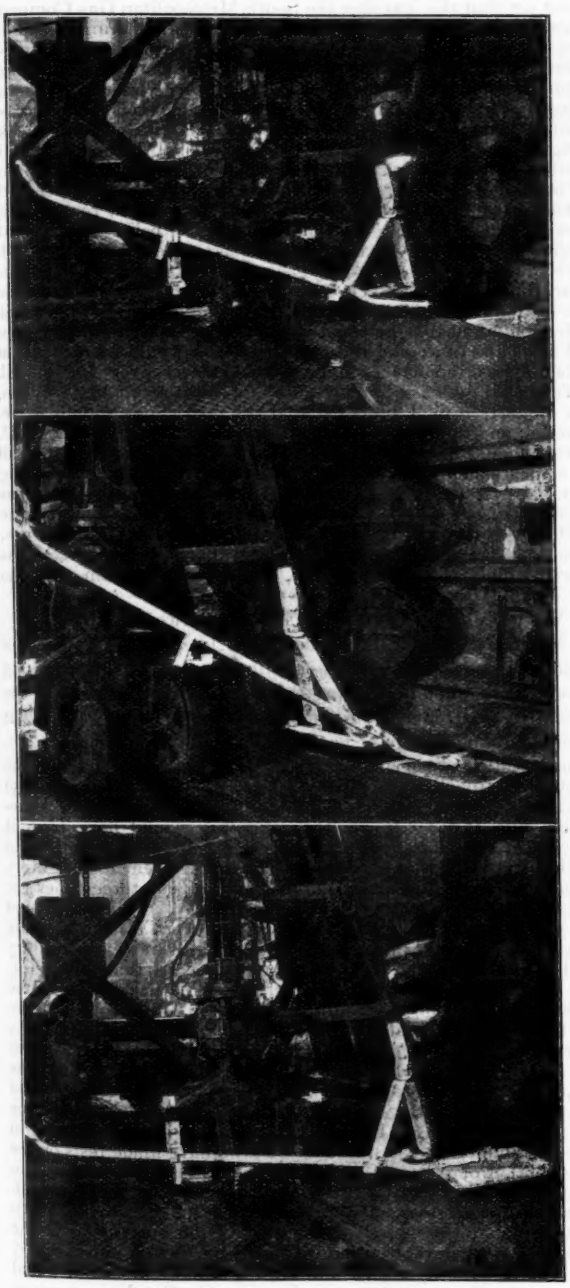


Fig. 17.—Showing the Working of the Producer Door Lifter.

interest. Whenever possible, gas making proper is discontinued between 6 a.m. and 10 p.m.; but this is varied by stoppage from 6 a.m. to 2 p.m., and from 6 a.m. to 6 p.m., according to circumstances. With a stop from 6 a.m. to 10 p.m., primary and secondary air slides are closed tight at 8 a.m. and are opened out again at 10 p.m.; a temperature of about 1200° C. being maintained in the combustion chambers from 10 a.m. to 10 p.m. The furnaces are filled by pushing out the hot coke from the retorts; and it is found that a setting of ten through retorts can be maintained at the above temperature throughout the day, and raised to its working temperature of 1300° C. at 12 midnight, by the use of about 15 cwt. of coke, or approximately 1 cwt. per hour. All air openings into the setting are stopped with clay, the cost of applying which amounts to a few pence only per setting. This is undoubtedly an economy, while the damage which is so often done by allowing cold air to enter retort-settings during the Sunday stop is avoided. The retorts from which the hot coke has been discharged are charged with coal; and in this way an appreciable quantity of gas is made. This in itself is an advantage, as gas made on Sundays is very expensive, while the charging-up of these retorts greatly assists in maintaining the make of gas of a good quality.

The author is of the opinion that it is no economy to reduce the amount of labour employed on Sundays below that necessary to ensure that the settings and furnaces at starting-time will be in good working order, and capable of dealing in an efficient manner with the normal requirements. Sunday inspections form part of the Company's system, and these cover all the faults which in the author's experience have caused bad heats and badly-working producers on Mondays after the Sunday stop.

WORKING WITH UNSEALED DIP-PIPES.

Since October, 1916, a large quantity of gas has been made in settings fitted with an arrangement by which the dip-pipes in the hydraulic mains remain unsealed throughout the whole time that the settings are working; the dips being sealed only when gas making is stopped on Sundays, or at other times. The liquor is maintained at a level half-an-inch under the bottom of the dip pipes; but in other respects the hydraulic mains are worked in the usual manner, liquor being used for flushing purposes, and tar drawn away through tar-pots attached to

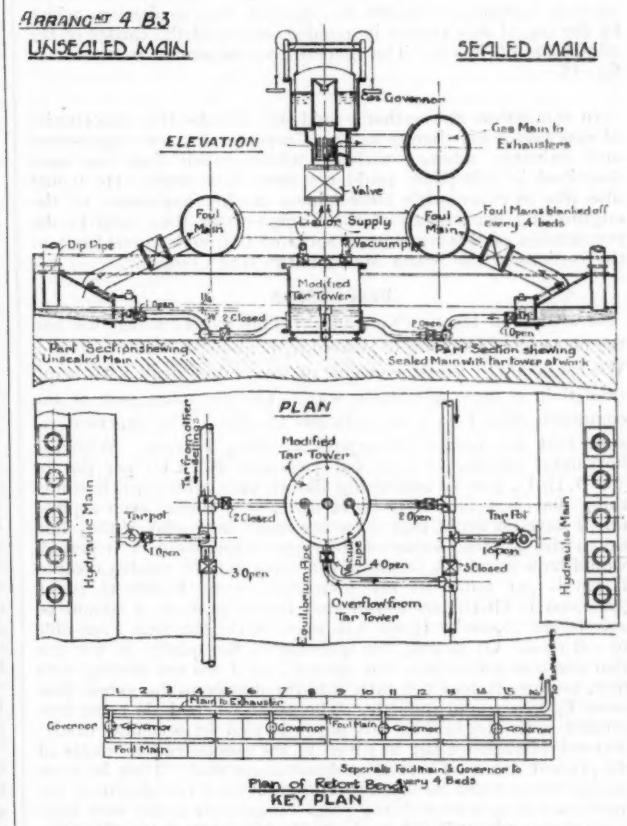


Fig. 18.—Showing the General Arrangement of Foul Mains and Connections Designed to Work with Unsealed Dip-Pipes.

each hydraulic main. With this system in use, it has been the practice to regulate the retort-house governors to maintain a level gauge in the ascension pipes of such retorts as are open during the draw; and in this way no gas descends, nor does air ascend, the ascension pipes.

When all retorts are shut, it is the custom to regulate the retort-house governors to give such pressure, level gauge, or vacuum in the retorts as may be necessary to maintain the desired quality. By this means, the oscillation of pressure and vacuum caused by the bubbling of the gas through liquor seals is avoided; and there is every reason to believe that there has been an increase in the amount of gas made per ton where this system has been adopted.

In ordinary working, it has been the practice to maintain a vacuum of one-tenth of an inch in the foul main while the doors are open (this giving level gauge in the ascension pipes), and a vacuum of half-an-inch while the doors are shut (this being found to be the correct adjustment for maintaining a quality of gas of a little over 550 B.Th.U. gross with normal quality of coal in use). The author would, however, point out that such a pull could not be exerted unless both retorts and retort-fittings were kept in a thoroughly good condition.

After instituting this system, it early became apparent that,

to obtain the full advantage, it would be necessary to split-up each retort-house into units of four or five settings only, in order that the long pull could be worked for a maximum amount of time; and this has been done in several retort-houses of the South Metropolitan Company. By this means, the long pull is being worked for 90 p.ct., and the short pull for 10 p.ct. of the time; the 10 p.ct. representing the proportion of time during which each unit has open retort-doors in one or other of its settings. As a matter of interest, it may be mentioned that, with this system, there is actually a vacuum in the retorts during the whole time the long pull is in operation.

To split up a retort-house into units, it is necessary to fit a separate retort-house governor to each unit, and to pass all the gas from the unit through this retort-house governor into the common collecting main from all units. For this purpose the foul mains are blanked-off between the units, with a small by-pass connecting adjoining units, for use when the settings are being dropped or picked up. On Sundays, when the settings are normally shut-down from 6 a.m. to 10 p.m., the dip pipes are sealed in the ordinary manner; and this is continued until the retorts are again charged in the evening.

The system has much to commend it, while no disadvantages have been observed, nor have any mishaps been experienced. There are 920 of the Company's retorts working under this system, and, so far as can be seen at present, all will be converted in the course of time. At one works, where this system has been in exclusive use since July, 1917, the total inerts—nitrogen, CO_2, and oxygen—have averaged 9 p.ct. only, which would seem to indicate, as might be expected, that oscillation, which by the use of this system is avoided, is one of the causes of the admission of inerts. The general arrangement is shown in fig. 18.

In conclusion, the author would like to take this opportunity of expressing his thanks to Dr. Carpenter for his suggestions and valuable advice, without which much that has been described in this paper could not have been done. He would also like to express his indebtedness to his assistants in the engineering department of the Company for their help in the preparation of this account of some of the work carried out at the stations of the South Metropolitan Gas Company.

DISCUSSION.

Mr. GEORGE HELPS (Nuneaton): This paper, which we had the pleasure of listening to yesterday, is unquestionably a classic. We could not, I think, conceive of the matter dealt with being treated in a more admirable way. On the main part of the communication I have no criticism to offer. The practical results that are dealt with surpass anything I know. With the horizontal retorts, to turn out 7,000,000 B.Th.U. per ton of 570 B.Th.U. gas, or something like it, year after year, is something that very few of us have done, or I think, even aspired to. I have no doubt that there are many here who, if they had taken the calorific value of their gas regularly over a period, would have to admit, possibly, that they did not reach 5,000,000 B.Th.U. per ton. In my own case, were I able to make 7,000,000 B.Th.U. per ton of coal by my process, I should be able to sell 10,000 or 15,000 c.ft. more to the ton than I am able to sell now. Of course, the question of the quality of the gas that one uses enters into this matter; but I am not dealing with that, because it does not enter into the matter to the extent that these figures would indicate. The point where I do come into conflict with Mr. Gill in this paper is that he sets out, firstly, that consideration must be given to the special requirements of the present time. There is no doubt about that. Then he summarizes them; and he says: "The great need for obtaining the maximum duty from existing plant on account of the very high cost of new plant." There is no doubt about that. Then he says: "The necessity of carbonizing the coal to yield the highest quantity and quality of gas, coke, and liquid products." Of course, that is very involved; but perhaps it is best summed up in the next paragraph, which states: "Arising from these desiderata, there is a great need to make the coal gas of the highest quality compatible with a maximum yield of therms. This is too obvious to need any argument." Now, from that point of view I am diametrically opposed to the whole system that Mr. Gill has so wonderfully put before us. We get right down to the question of quality. What is quality? Gas engineers, in my opinion, everyone of us, have always worked from the wrong end of our job, or their job. They have never considered combustion from the consumers' end. Therefore, they continue to send out that gas which the consumer does not want, but has to pay for. What do we mean by quality? Do we realize that the mixture the consumer should have at the outlet of his burner should consist only of something like 15 p.ct. of combustibles and 85 p.ct. of air? Do we realize that? We have known it long enough. If we do realize it, why on earth do we continue to send out a rich gas? The quality of the mixture that the consumer uses in B.Th.U. would be something like 80 to 85. There may be something controversial in what I have to say this morning; but there is nothing controversial about that; and I believe the statement can be admitted by you to be quite scientific.

What is bad gas? We heard yesterday people talking about nasty gas. What is nasty gas? I would say that all gas is nasty when improperly used; and there are a good many other things that are nasty when improperly used. Those of us who indulge at all in those things that are sometimes refreshing [Laughter] find that if we do not use them properly they are very nasty, particularly in the morning. Water is an excellent thing, but improperly used—and sometimes we do improperly use it—we can get inundated with it; and I do not think there is any question at all about it that people, when they talk of nasty gas, do not know what they mean. The nastiest gas that I know is the richest gas; and I tell you it is nasty in many ways. It is a great waste. We all know the very worst form of luxury is waste, because it cannot possibly be consumed; and I stand here and say that this gas that the South Metropolitan Gas Company are sending out, excellently as it is made, is not being consumed by the consumers at the supply point, and can never be, unless the pressures and the appliances are entirely changed. This question of what gas is, and what gas is not, is, of course, the most important matter that we can discuss. Let me put another case before you. Produce a gas of about 120 B.Th.U. I am speaking of coke. If the heat that is lost in cooling be added to it, it will do any merciful thing that a gas of 600 B.Th.U. will do. That is not controversial—I believe you will all quite agree with that. And then what do we get down to? What reason have we for sending out a gas of high quality? I believe you will all agree that the only reason is the question of distribution. If we could send the consumer gas of a quality that I referred to earlier, of about 85 B.Th.U., it would be the best stuff for him to use; and it could not be called nasty in any sense of the word. He would find that he could use it and get a high efficiency out of it all the time, and the pressure which would be required at his nipples or appliances to use it would be very, very low indeed. We should get back to a pressure of 4/10ths or 5/10ths. When, in August, 1916, I proposed that all restrictions should be removed, and that gas of about 350 B.Th.U. net and 400 B.Th.U. gross should be sent out, I was laughed at. But what are all you gentlemen doing to-day? How many of you are sending out gas over 400 B.Th.U.? At that time—August, 1916—the gas being sent out was between 500 and 600 B.Th.U. Now I come before you this morning and I say that 400 to 500 B.Th.U. gas, which is the general quality I believe that is being sent out, is far too high. I am sending out, and very proud I am of it, 250 B.Th.U. gross.

Mr. W. M. CARR (Ormskirk): At what price?

Mr. HELPS: Price I will deal with later on, if you do not mind. Price has nothing to do with the question I am talking about now. You are raising the question that I raised to the scientists yesterday. I am sending out 250 B.Th.U. gas. What would be the quantity of gas that the South Metropolitan Company could send out making 7,000,000 B.Th.U. per ton? If the South Metropolitan Company diluted their gas down to 250 B.Th.U., as I am doing, I think it would work out to something like 45,000 c.ft. per ton; and they would have from it 8 cwt. of coke, tar, and a considerable amount of ammonia to sell. And I say that so doing would enable them to give every consumer—and this applies to everyone of us—three times the gas he is to-day having for the same money. This may sound to you as ridiculous as you like to make it, but it is an absolute fact, and can be demonstrated. And, what is more, the country will see that they get it; the consumers will see that they get it. If the question of distribution be considered in relation to the present practice of the South Metropolitan Company, I figure it that at the present time, taking their gas at 600 B.Th.U., they could, if they reduced this to 250 B.Th.U., make 11,000,000 B.Th.U. per ton, and 19,000 c.ft. They would have to distribute 42,000 c.ft. for the same B.Th.U. That is what stops a lot of us people from getting on with the manufacture and distribution of a low-grade gas. Those of you who are really interested in the distribution of gas, those of you who have made tests on the distribution of gas, will see and agree with me as to the compensating factors that exist. They are very, very wonderful. There is about two-and-a-quarter times the gas to be distributed; but the pressure at the outlet of the main pipes or the nipples, or whatever you like to call them, is very much lower. This extra quantity is distributed with, roundly, the same initial pressures. Does not that sound utter rot? But I am not here to tell you gentlemen anything that I have not done. If you come down to Nuneaton I can show you practically the same initial pressures at the works dealing with 250 B.Th.U. gas that dealt with 500 B.Th.U. gas. Is that good enough, if I can do it? There can be no question that the whole matter of the quality of gas depends on this effect of distribution, and the more you take the trouble to look into it, the more fascinating you will find it. Most people are always given to discussion rather than operation and practice; and I often wish that, instead of discussing so much round the table, we would just simply leave the table sometimes and go into the works and put into operation these very things that we waste so much time in discussing. There were several more notes that I had made on this matter; but I am afraid I have already occupied your time too much. I have been speaking actually of the quality of gas and endeavouring to put to you the reasons why I am dead-against

anybody sending out such a gas as Mr. Gill has put before us in this paper; and I hope that something will be done so that the consumer shall have this, because if what I say is right, they can have three times the quantity in British thermal units for the same price. If so we ought to do something, and do it speedily, so that the consumer obtains what he wants.

The PRESIDENT: I think it would add very much to the value of Mr. Helps's remarks if he could give the meeting any rough analysis, showing the amount of diluents in this 250 B.Th.U. gas. I take it he is sending out a good proportion of carbon dioxide and nitrogen.

Mr. HELPS: As little as possible of carbon dioxide.

The PRESIDENT: I quite understand that; but it would help us if you could give us an approximate figure.

Mr. HELPS: I will look it up and give you the amount. I have got it somewhere. I can give you the inerts. Many people will say, "What are you doing yourself?" Well, consider the matter from such facts as these. I am not Chairman of the Nuneaton Gas Company; and it has been extremely difficult for me to get out into the town this quality of gas. There is no reason now why I should not tell you that originally, when I started getting down to 300 B.Th.U., my Directors knew nothing at all about it [Laughter]; and you will quite realize that if they had known they would not have let me go on. From that, I may say, I got down to 250 B.Th.U.; but it was the coal strike that came along and enabled me to do it. I turned it on as soon as I could; and when you come to think that I had only the most awful bastard plant, you can imagine very well that I have only used the plant just to show what can be done, and to prove the matters I have been endeavouring to put before you this morning in so far as distribution is concerned. I have sent out some most filthy stuff; but it could not really be called bad gas. At the present time, if I were sending out gas as I should be doing, under the ordinary working conditions of carbonization, I should require 12,000 tons of coal to be brought from a distance of 50 or 60 miles. But what I can do now that the restrictions are removed is to send out all the British thermal units I require with about 2000 to 2500 tons of local coal; and when we get the plant going, as we expect one of these days, and when I can persuade my Directors that there is really something in what I am talking about, we shall be able to give the consumers three times the gas for the same money, and the works will run themselves. I do not know whether that answers my friend who spoke about price. Our price is 3s. 5d. per 1000 c.ft. for 250 B.Th.U. gas. Work that out, and you will find it is costing the consumer a terrible lot. But you wait a month or two; and then I will show you what we can give the consumer for the same money. We have just started working from the consumer's end, and in a very few months he will have twice the gas he is getting, or more, for the same money. The only excuse I have for occupying your time this morning is this, that I am touring the country, demonstrating to the whole of the consumers in the community that they can have three times the heat energy for the same money; and my ideas of fairness made it incumbent on me to stand up before you gentlemen this morning and declare this. I thought you might consider it not to be fair if I started getting round to the consumers and talking to them about it when I had not put it before you. Though I may be a fanatic in the opinion of some of you, I am not so much of a fanatic as you imagine.

Mr. S. B. LANGLANDS (Glasgow): I think, if Mr. Gill's paper has done nothing else than put the brake on some of the extravagant notions with regard to the value of gas, it has served its purpose. Just now I think we are hardly ready for gases of 250 B.Th.U. Will the consumers stand anything less than 400 B.Th.U. if they will not stand 450 B.Th.U.? As one of the largest consumers of gas, we know that, with our works as they were in 1914, we were doing anything between 500 and 600 B.Th.U.; but you cannot do things by revolution. Must not it be done by evolution? The whole of the gas industry has been built up by the steady, quiet evolving of real scientific principles. And all this wild talk of coming down in British thermal units, what is it for? Dividends? Is it for dividends? I am afraid it is. It certainly is not serving the consumer.

Mr. W. H. WARREN (Beckton): I have listened to Mr. Gill's paper with a great deal of interest and a good deal of doubt. Mr. Gill is working towards maximum efficiency in carbonizing, and is apparently doing it very thoroughly; and one can, with very few exceptions, hardly quarrel with his methods. At the same time, Mr. Gill is making sacrifices in other directions. The use of small retorts lends itself very well to their being set in cross walls of 4½ in. thickness; and thereby Mr. Gill can very well claim an increase in heating efficiency of his settings. But, at the same time, the working costs and other costs in the retort-house depend on the number of retorts in use, almost irrespective of the capacity of them. With further reference to Mr. Gill's claim that he gets superior thermal efficiency in his settings by the use of meagre cross walls, I would instance that we have a similar set in use at Beckton; but the cross walls are very much heavier. The retorts are shielded with silica; and the total area of retort covered by brickwork approximates to 60 p.ct., against Mr. Gill's 41 p.ct. Yet we are able to do the same work in these settings at temperatures approximating to 100° lower. I do not attempt to explain this apparent phenomenon; but there it is. It may be a question of pyrometry. We use the Féry pyrometer; and we take our temperatures in the zone of combustion. Further, with regard to the machines that Mr. Gill has mentioned, these are machines which almost preclude the use of really economical coal-handling plant; and they are also in themselves comparatively expensive to work and to maintain. This really seems an almost unnecessary sacrifice. There are at least three machines on the market which are able to work from one side of the setting, and have not the disability of restricting the size and type of the charge. It may be interesting in this respect if I tell you what we have done at Beckton with regard to the old West scoop machine, which, by the way, has the very disability to which Mr. Gill so rightly objects. It does restrict the size and type of charge. We have, at very small cost, converted these West scoop machines into De Brouwer machines. I might explain that the De Brouwer people supply a conversion which can be introduced into the old frame of the West scoop machine, and which makes use of the prime mover. By this means we have saved a great deal in labour, and have also been able to increase our throughput by getting in a larger charge. The remarkable care that Mr. Gill takes to keep his lids and mouthpieces of the retorts gas-tight, and the almost excessive supervision involved, represents further sacrifices in the cause of efficiency. Surely the successful working of the retort-house does not depend so much upon attaining a sort of academic perfection in working? A compromise must be effected. Though it is exceedingly important to get the very greatest number of therms per ton of coal, surely some consideration must be given to the number of therms one can get for a pound sterling. For this reason, I wish Mr. Gill had given us some costs, or some analysis of the costs per therm at the outlet of the retort-house, for instance. This would have been very useful—more particularly so, because the argument that Mr. Gill puts forward early in his paper appears to me to be quite unsound. Mr. Gill says that 68 p.ct. of the expenditure in the retort-house is on coal, or is it 81 p.ct.? Has Mr. Gill charged his coke twice, I wonder? If, however, 68 p.ct. is the expenditure on coal, therefore the greatest possible saving is on this 68 p.ct., says Mr. Gill. I do not see that this follows at all. Even the most stupid of us manages to get something back of the 68 p.ct. from residuals. Often, in a favourable state of the residuals market, our coal costs us very little indeed. I can point, and I know Mr. Gill can, to recent times, when the coal has cost us very little.

Mr. W. M. CARR (Ormskirk): I rise to congratulate Mr. Gill upon directing our attention, in his very excellent paper, to commercial values. Following the war, my own experience has been, starting once again, more or less, that we have largely lost our ideas of commercial values—that is to say, we hear our friend Mr. Helps, for instance, telling us about complete gasification. We hear also of large schemes of works expenditure to save certain sums of money; but are we not very often losing the incidence of the capital expenditure, which is a very great thing at the present moment—that is, the incidence of capital in relation to the saving to be effected in revenue? I think that many of us have to be content to go on, perhaps, conservative lines; and that we are not losing a great deal in the meantime. The results given in the paper show what can be done with horizontal settings by supervision. Mr. Helps referred to gas of 250 B.Th.U. at a cost, as he said, of 3s. 5d. per 1000 c.ft.; and he admitted that it was very expensive gas. He tells us that we must wait. We have waited. We heard this last year, and, I think, the year before; and we are still waiting for commercial figures. With regard to the pressure. At the same initial pressure, Mr. Helps tells us he is giving the same result with 250 B.Th.U. gas as with 500 B.Th.U. gas. I would like to ask, if I am in order in doing so, if Mr. Helps has doubled his gasholders and doubled the size of his mains. From the practical point of view, that is the only way I can see it can be done with the same incidence at the works. I agree that greater efficiency can be obtained with different classes of apparatus and different adjustments; but given the best apparatus and the best adjustments in both cases, the only thing that can affect it in the practical sense—and, after all, we are practical men, as well as scientific men, I hope—is the size of the holders and mains. To be told that we can get the same results with the same pressure with a 250 B.Th.U. gas as with a 500 B.Th.U. gas requires some further explanation.

Mr. H. E. JONES: May I offer a few words, not by way of controversy; but we are very much agitated to-day on this question of high and low quality gas? Now, we have during the strike, and during the war, when we were short of coal through the action of submarines, been driven, whether we liked it or not—some of us respectable and decent old companies who are anxious to supply a respectable and decent gas—to supply some rather bad stuff, like Mr. Helps. [Laughter.] He said so, you know; and I agree with him. We have all been sending out, during the coal strike, some filthy stuff. I know one company,

of which I am proud that I have been associated with all my life, were reduced, by empty coal-stores, to bringing the quality of their gas down to nearer 400 B.Th.U. than I liked. This took place just before I saw in the "Gas World" a very useful little table showing the difference in the statutory declarations of the quality of gas that were proposed to be supplied under the new regulations; and, in a joking spirit, I am afraid I rather made fun of the extreme width of the scale—some being as high as the South Metropolitan gas, and others as low 350 B.Th.U. Wandsworth gas during the strike on frequent occasions was 420 B.Th.U. This is what amazed me, and what enlightened me—that so long as we could keep the supply of a sufficient quantity at 420 B.Th.U., the consumers were satisfied. Even members of my own family who live in the area did not complain; and it all made me scratch my head. I thought, "What is the matter with this? It ought not to be. We used to send out 600 B.Th.U. gas in the old days, when we supplied at 14 c.p. through the Referees' burner; and now we send out 420 B.Th.U. gas, and the consumers do not complain." By the way, the real illuminating value of 14 c.p. gas was only arrived at a few years back through the Carpenter burner. That burner has done an enormous service to the gas industry. If we had been converted to calorific value in the old 600 B.Th.U. days, when we had to supply 14 c.p. gas, through the Metropolitan burner, we should never have got the terms we have got to-day, in any shape or form. We should never have got down our standards. The bridge between illuminating power and thermal value that gave safety and success and prosperity to the gas industry was the Carpenter burner; and as long as gas lasts, this fact, I hope, will be crystallized and remembered in the minds of all.

But coming back to this question of the quality of gas, I am not going to say that Mr. Helps is right or that he is wrong. He is very original, and very bold; and he makes me think. I am not going to say that Mr. Gill is right, or that he is not. The truth must lie somewhere between the two. We have had an object-lesson during the recent strike and the submarine action during the war, when limitations were all removed; and we have enjoyed a freedom that we never had before. It is my deliberate conviction, arrived at from the daily inspection of the sending out of gas by a large company and the success of the distribution, that you can make a gas of 400 B.Th.U. serviceable in all these relations, if you only bring enough of it at the right pressure to the nipple. Distribution systems are enormously dear now. We cannot pipe at less than four times the cost before the war; but the price of these things must come down. We must force them down, and make them ourselves, if there is no other way. The price of pipes and stoves and other things is appalling; and the price of gas is appalling. We cannot go on expecting the consumer to give us the prosperity we have enjoyed in the past, charging the prices we are doing to-day. They appal me as an old gas man; and if I were in charge of a distributing plant, I am not sure that I should say that the man with a 400 B.Th.U. gas was wrong. I should let him work out his own salvation, and ask him to let me work out mine. I kept my own declaration in the case of the Wandsworth Company as near as I could to the old standard twelve years ago, when we were in Parliament—viz., 480 B.Th.U.—because otherwise I thought I should be breaking a bargain. But I am not sure I should not go lower if I had to do it again to-day. I am not making any argument against Mr. Helps or Mr. Gill; but we have all had an opportunity of learning something from this paper and discussion. I learned a great deal during the great war; and you are never too old to learn, although you are as white as I am.

Mr. J. W. Whimster (Bath): I would like to add my congratulations to the author. As a horizontal man, I have studied the paper very carefully, and find a lot of food for thought in it. There are several points one would, perhaps, like to criticize; but I notice that Mr. Gill is in a hurry to get away, and will try and be as short as possible. Mr. Warren referred to the point that in the costs apportionment £68 is for coal. That, I think, is wrong. It is the total cost for coal, I think. Mr. Gill has allowed for cost of coke for the furnaces, £13; and if this is allowed for, I take it Mr. Gill owes the coal something. Then as regards carbonizing wages I do not know whether Mr. Gill means to infer that these are a minor item, and should not be looked into. I think they are a very big item. Taking present-day costs of coal and residuals, the net cost of coal is practically *nil;* but carbonizing wages are an item. Another point is that Mr. Gill has given us the cost of the inspection; and this inspection certainly seems to be very elaborate, and an excellent arrangement. But we would like to know, not only the cost of the inspection, but the cost of carrying out the repairs necessary through the inspection. I quite agree with everything Mr. Gill has said with reference to producers for horizontals. Usually the producer is bunged underneath the setting; but he has an excellent opportunity, in not having generators, to erect a good big producer outside, where it is easily filled. Those of us who have regenerators know that the producer comes rather in the way of cleaning the flues. Has Mr. Gill made any experiments with having the damper on the outlet of the producer, as a producer which feeds the three settings is very adaptable to having a damper on each of the settings at the outlet of the producer, and thereby doing away with the necessity for primary air slides, and simply having the furnaces open? I should like to know if Mr. Gill has experimented in this way. It would also be interesting to have some figures of the saving in fuel due to the insulation of the settings. Few of us insulate our settings; and it would be useful to know what saving can be effected. The coke made for sale is certainly an astounding figure—12 cwt. sold, not taking into account what is used on the works, and which most of us take into account. So that it must be from 12½ to 13 cwt., which is very large. Has Mr. Gill made tests of the fuel used in the furnaces, apart from the quantity sold? There is only one other small point, and that is with reference to the Sunday shutting-down. I see that this necessitates pushing out so many charges during the day, which means stokers coming in, and also power men to operate the machines. There is also 15 cwt. of coke per day in maintaining the heat. In our own case, we adopt the principle of closing-down at 6 o'clock in the morning, having fired at 5 o'clock. We close the main dampers, which Mr. Gill does not mention, and the primary air, but do not close the secondaries altogether, because there is always a certain amount of leakage, and you may as well use that gas by admitting some of the secondary air to the burners in the combustion chamber. Then we open-up at 8 o'clock at night, and start straightaway by filling a portion of the producer at 10 o'clock. We do not use any coke during the day, and the furnaces do not go down far; and by 9 o'clock in the morning on Monday things are normal.

Mr. P. S. Hoyte (Plymouth): I had hoped that the presence of Mr. Helps here, representing as he does a system which is essentially totally different from that dealt with in the valuable paper of Mr. Gill, would have led to what, after all, is the *crux* of the matter—viz., the relative cost of the two systems. We have in this paper what I think can be regarded, for many years, if not for all time, as the last word in what we might call the old system of carbonizing in horizontal retort-settings. Those of us who have horizontals only wish we were getting anything approaching the results obtained by Mr. Gill at the South Metropolitan Gas Company's works; but it is what we should have expected from what we know of the scientific way in which works practice is carried out by Mr. Gill. It is a matter we shall have to figure-out. Mr. Helps has not given any figures of cost that are of value at the moment. Total costs can roughly be divided into capital outlay on the works and the cost of materials, labour, and distribution. On paper, it would be quite possible to demonstrate that your capital outlay on (say) a producer plant, and the works cost in working it, and possibly your thermal efficiency, are cheaper than horizontal working, even producing as much as 70 therms per ton of coal. But the distribution question is the *crux*. We are tied at the present time to a cast-iron system—it is cast iron in more senses than the material—and at the end of our system of mains we have the meters. Is any one of us convinced that he can distribute 25 B.Th.U. gas through the same sized mains and at the same pressure as 500 to 570 B.Th.U. gas is being distributed? There is hardly a works in the country that is not much under-metered. ["Hear, hear."] At Plymouth, we have 20,000 3-light slot meters. What is a 3-light meter? It is a meter for three lights—18 c.ft. per hour—and yet cookers and fires are being connected up every day; and they are all under-metered. I think the same thing applies very largely to one's ordinary consumers. There are hundreds and thousands of 5-light and 10-light meters which are under their work. We are putting on fires and cookers, but are not enlarging our meters at the same time; and we have this enormous capital outlay to face, if we drop down. I am not speaking of dropping from 500 to 400 or 425 B.Th.U. gas, but dropping down to producer gas, which is, in effect, what Mr. Helps is distributing. That is going to put an enormous burden on our distributing system, and especially on our meters; and it is for every one of us to figure out whether the saving in works costs, materials, or labour and capital outlay is such as to justify practically re-canalizing and re-metering the whole of our system.

Mr. Helps: I might as well answer what Mr. Hoyte has just said. I will endeavour to give you a few figures. I could have brought a good many with me, but I will give you these. The South Metropolitan Gas Company have charged against repairs and maintenance in the last balance-sheet £900,000. I think a complete plant for sending out 300 B.Th.U. gas could be put down for a less sum. That is some figure of the cost for all of us to be going on with.

Mr. Carr: What about the mains?

Mr. Helps: I have said what I have to say about the mains. You have disputed the fact that the distribution is as I have said; but if you will honour me with a visit, I will show you whether what I have said is correct or not.

Mr. Carr: Thank you.

Mr. J. G. Tooms (Christiania): My only object in taking part in this discussion is to ask Mr. Gill, when replying, to give us some particulars of whether he has considered adapting his outside producers to use breeze. With the mechanical handling of coke that we all have in force, we have an increasing quantity

of breeze made; and I am aware that on the Continent this matter has been successfully solved of utilizing breeze for heating the retort-settings. There is just one other thing I should like to say. As the chief of a moderate-size works, I thoroughly agree with what Mr. Gill has said about this extra supervision. When I can say this for a moderate-size gas-works, how much more important does it become in a works of the magnitude of the one Mr. Gill is connected with? All my working career I have found that the regular testing of retort-settings by semi-skilled, and in many cases technical, assistants has paid hands down, and it may be of service if I emphasize this part of Mr. Gill's paper. I am particularly interested, however, in this question of the use of coke breeze; and I am sure Mr. Gill has some information he can give us.

Mr. GILL: I am quite pleased with the discussion on my paper, though I expected very many more contentious things. Mr. George Helps I thank for his kind remarks. He said that he was unable to get more than 5,000,000 B.Th.U. from a ton of coal; but I daresay his coal is not so good as ours. I explained at the beginning of my paper that our coal comes from Durham and Northumberland; and I also gave an analysis, so that you could really see the kind of stuff we had. Of course, in my paper I was only attempting to deal with our existing plant. I was not showing how much better it would be if we had got something else. I think it is a matter of considerable importance that we should all try to make the best of what we have got, until capital charges are again reduced. Of course, in my paper I was not dealing with the quality of gas that should be supplied. The title was "Carbonization in Horizontal Retorts." It was not "What Quality of Gas Shall we Supply?" This would need a paper of itself. It may be that time will show that the gas quality ought to be either higher or lower; and I am sure if Dr. Carpenter were here he would tell you that he is sitting on the fence, like everybody else; and if he were convinced that the quality should be lowered, he would change as quickly as he changed from cubic feet to therms. We are all, surely, now "waiting and seeing." At any rate, my job at the moment is to do the best I can with the plant we have got. I am wondering what my Directors would say if I started sending out gas of 350 B.Th.U. [Laughter.] They would not remain my Directors for long. But they would stay where they are. [Applause.] Mr. Langlands made a point of the fact that we are not ready for very low-grade gas. I think that is quite a strong point. The distribution problems would be too great. If the change is to be made, it must, I think, be a slow one. Mr. Warren spoke about a number of details in my paper. I believe he made a point that large retorts would be better than small ones. It may be that they would; but personally I do not think so. Again, there, I was not comparing in any part of my paper small retorts with large ones. I was simply giving you a few notes on what we are doing at the moment. He also somewhat criticized the small cross-walls which we use; and he spoke of a retort-house where 50 p.ct. of the retort surface was covered by supporting walls and protecting blocks, whereas in our case it is 41 p.ct. I cannot but think that, if you can get retorts to give a long and satisfactory life, the smaller you can make their supporting walls the better. The heat must be able to be transmitted through the thickness of the retort better where there is no wall than where there is one. He also said that our machines would probably be uneconomical in working. Having to have two machines, one on each side of the setting, is, of course, a disadvantage. You have to have coal-handling plant on both sides. But this is what we have existing; and personally I have not come across a machine which will put in so large a charge in proportion to the size of retort as the ones I mention in my paper, and which we have in our works—that is, the Arrol-Foulis machine and the West scoop machine. It is certainly surprising that the West scoop machine should be able to put in so large a charge; but any of you who have been to Old Kent Road will probably have noticed what a large charge is put into these small retorts by these scoop machines. We are putting 10½ cwt. into a 20 ft. retort which is certainly very small in cross section. Personally, I do not want to scrap the West scoop machine. I think it is an excellent machine. Mr. Warren then spoke of tight lids. I do not think it needs any argument on my part to show how important this is. It is obvious. You have a retort that can take in a very great deal in the way of air and furnace gases, and can lose a great deal out in the form of gas; and the tighter you can keep it, the better. We spend very little on keeping our lids tight. It is quite surprising how small the amount is. I have not the figures here; but they have always impressed me with their smallness. I do not think the trouble we take is wasted money at all. I mention that in the case of the inspections the cost is only ½d. per ton of coal carbonized. When you are paying round about 30s. per ton for your coal, ½d. is very trifling; and if it helps you to secure only a fractional advantage in improved results, it is well repaid. Mr. Warren further spoke of the figures I gave as to how the 100 p.ct. expended in the retort-house is divided-up. I showed there that £68 out of the £100 is spent on coal. Well, I know it is arguable as to whether that is the best way to put it; and, in fact, I thought of putting it several ways. But in our own private lives we have to analyze our expenditure; and here I am simply analyzing the expenditure alone in the working of the retort-house. I put it in because I think it throws rather a new light on the way we might look at the cost of working a retort-house. If coal became very much cheaper, my argument might change; but it is not cheap yet.

I think Mr. Carr agreed with the various points raised in the paper. I was very glad to hear Mr. Harry Jones speak on the paper. As you may know, I was a pupil of his; and very glad I am that I was. Mr. Jones said that the high price of gas is appalling; and I quite agree with him. It is appalling; and it is quite time that we did something to bring it down. From all that he said on the subject of the quality of gas, it is clear that Mr. Jones also, with all his experience, is sitting on the fence, to see what is going to be proved the best. Mr. Whimster referred to the same figures that I have already mentioned. The £68 is for coal, and £13 for fuel. The latter figure is the cost of the coke used in the furnaces—the difference between what is made and what is sold. I agree with him that carbonizing wages are not a minor item. I do not wish this to be taken as my opinion. All I was trying to do was to direct your attention to another side of the question. Most of us have been considering what is the best type of machinery to use to save labour in the retort-house. No damper such as Mr. Whimster refers to is, so far as I can see, needed. All that is required is to regulate the dampers in the waste-gas flues to each setting. Again, I have no figures to give you of the savings from insulating the settings. All I can say is that the amount of coke which we are selling per ton of coal carbonized has been steadily increasing; and so I imagine that what we are doing is at any rate saving fuel The figures Mr. Whimster speaks about of coke sold per ton of coal is mentioned in the paper. One of the diagrams refers to one works only, where we have been putting in most of these new grates. It does not refer to the whole of my Company's works. But the other diagram in the paper, which gives the coke sold per ton of coal for, I believe, the last seven years, refers to the whole of the works. In reply to Mr. Tooms, I may say that we have not used breeze in our outside producers. We use under our boilers practically all the breeze we make; and there would be no great gain in doing what he suggests, as we should not have the breeze with which to supply the producers. I am glad to hear from Mr. Tooms that he agrees that more supervision is wanted in the retort-house. This is, I think, really the key-note of what I have attempted to put before you.

The PRESIDENT: I should just like to say that it seems to me, whatever differences of opinion gentlemen in this room may have, we are all agreed in the duty we owe Mr. Gill for this most excellent paper. [Hear, hear.] There is a very good reason for it being dealt with, and that is in reference to the very high cost which we have to incur for alterations of plant at the present time. To reconstruct a large retort-house, such as those Mr. Gill has under his supervision, is something staggering in the first place; and when Mr. Gill can get such results as he does, it is very patent that at present prices it must be very difficult for him to justify the enormous expense of entirely reconstructing the retort-houses and going for a new system in order to get the small economy which the peak load represents. He probably has a 90 to 95 p.ct. economy; and it would be difficult to justify, at present prices, going to an enormous expense to realize the small additional percentage which might or might not be attained. Horizontal retorts are evidently going to last some time yet; and we must always recollect this about horizontal retorts—that no matter what coal you are able to buy (and in a large concern it is often difficult to choose coal) you can carbonize it in the horizontal retort. That is of tremendous value. Mr. Gill has shown us what I think can be taken as the ideal in carbonization, to get 70 therms as he does. I noticed that in earlier years he got 75, and I have not the slightest doubt he will get them again, which is a feat any engineer can be very proud of. Whether it is worth the cost of the inspection that Mr. Gill has described in his paper or not, is entirely a matter for each one of us who has a plant under his supervision to determine for himself. In the face of the costs which Mr. Gill gets, I should certainly say it is worth it, and with regard to all these other matters of cost, we have to recollect not what the cost of working a particular machine is, but what the total balance is when we come to work-out the whole cost of production in therms per ton, because that is what it comes to. What may suit in one place may not suit in another; but we have one common object in view, and that is to make gas at the lowest possible price in therms, and at the same time a gas that is useful to the consumer for the particular purpose for which he requires it. The matter of the different qualities of gas, which has been introduced in the discussion, is really foreign to the paper. I quite agree with Mr. Langlands that it does not do to alter methods too drastically. All our distribution systems have been laid down so as to deal with a 14 or 16 candle power gas, and I do not think we can supply the consumer with an ample number of therms with our present systems, with a considerable fall in the calorific value; but if we supply him with a small reduction in the calorific value, such as we are doing—anything between 400 and 500 B.Th.U. is the figure I have in mind—we can supply him satisfactorily. Of this I am certain, that in a large number of under-

takings, if we suddenly drop down to a very low calorific value, such as has been mentioned, we shall involve ourselves in endless difficulties. In our own concern, we are pushed sometimes even now to supply the consumer with the gas he requires, and I must remind you that the number of consumers tends to increase. The use of gas at the present time is vastly on the increase; and it must increase, because of the difficulties connected not only with the obtaining of coal but by reason of the increased demand at the present moment for cleanliness in the house and the reduction of labour in the house, which is a very serious matter and a thing much to be desired. For this reason I very much deprecate any sudden revolution with regard to the change of calorific value. We must feel our way down and test our distributing plants as we go along; and I am glad to hear that most undertakings, in declaring the calorific value at which they are going to supply, are working in that direction. I feel it is the only wise course we can adopt. Our hearty thanks are due to Mr. Gill for his paper.

REPORT OF THE LIFE OF GAS-METERS JOINT COMMITTEE.

[The Report was published in the "JOURNAL" for Aug. 17, p. 377.]

Presented by B. R. PARKINSON.

The President has very kindly asked me to present this report, though he himself has taken the keenest interest in its production, and in all the work of the Committee of which he has been Chairman.

The first section of the report dealing with chemical and physical considerations is brief and confined to matter which leads to definite conclusions. Mr. Taplay, Chemist to the Committee, works always for practical results, and his final reference to the possible elimination of hydrocyanic acid from the gas by a process within reach of all undertakings may prove to be of first-rate importance to the industry.

The Life of Gas Meters Committee may have appeared to go beyond its functions in taking-up the subject of the internal corrosion of mains and services. Investigation however has proved that the subject is relevant, and the enlargement of the field of research has undoubtedly made clearer the issues. The origin of the corrosion investigation was a sample of oxide dust which came from Singapore. Inquiries led to the discovery that many similar cases were occurring in this country, mostly in high-pressure distribution systems. This can probably be explained by the fact that at high pressure the gas is forced to its dew-point, and with the deposition of moisture in the mains corrosion has its favourable opportunity. In the present report, as in the two previous ones, gas engineers are strongly recommended to take the opportunity so freely offered by high-pressure distribution to effect this extra condensation on the works, and not in the mains, by raising the gas to a higher pressure than is required for transmission, cooling it in a receiver or condenser on the works, and then letting the pressure down (perhaps a few pounds) before passing the gas into the mains. Here is a practical positive proposition. There is another one of a negative character which also has to do with the deposition of moisture, right at the far end of the distribution system. Consumers' meters will act as condensers if they are exposed to cold and damp; and it is with condensation that most of the internal troubles occur. They should be reasonably protected from extremes of temperature, and undoubtedly their lives will be prolonged. Is it too much to ask that a gas-meter should receive somewhat the same consideration as a clock?

The second section of the report gives the results of a questionnaire on the advantages of spraying meters; also of introducing oil vapour into mains. The evidence collected in both cases is very favourable; and the Committee are inclined to lay emphasis upon the latter. The extracts from the American reports are well worth reading, particularly by those who are interested either in testing or handling meters. It is evident that our friends across the water have read our reports, and the interchange of experience should be helpful. They have taken up the spraying idea from us, and they speak of it as "oiling meter valves."

In the fourth section the Committee take credit for a good deal of work on the amendment of the Sales of Gas Act, the results of which were ultimately merged into the new Gas Regulation Act now in operation. The fifth section repeats the new standard list of dry meters which figured in the report of the Council. The Committee express the hope that all gas undertakings will endeavour to arrange their requirements in the near future so as to conform with this schedule.

DISCUSSION.

The PRESIDENT: Before I move the adoption of the report, I should be glad to have any remarks that members may think fit to make. The work of the Life of Gas Meters Joint Committee continues to be exceedingly useful, and not the least useful of the Committee's work is the simple mode of eliminating cyanogen, that has been found so harmful. Mr. Taplay will probably be saying something about this matter. I do not intend to say anything more at this moment with regard to the contents of the report, except to emphasize what Mr. Parkinson said in the latter part of his remarks. I will draw your attention to the particulars of the new standard sizes of dry meters, with the object of reminding members that these have already been agreed to by the Institution, and should be ordered as soon as possible in place of the old sizes. Meters of the new sizes are promised by the makers at the end of the year; and if the end of the year can be anticipated, they will use every effort to do so. We shall hope to see standard meters in use on the districts before very long. I shall be glad to hear any comments on the subject of the report.

Mr. ALBERT W. GLOVER (London): In seconding the adoption of the report, I would like to draw your attention to the very interesting *résumé* of the results of the investigations of the American Committee who have been conducting a somewhat similar inquiry to our own; and the conclusions incorporated in your Committee's report are not the least useful portion of the report. For instance, they mention that "one large company started a record of meter tests arranged according to years of service. After seven years of service, the net error 'slow' increased rapidly, showing conclusively that meters should be changed at the end of seven years, in order to protect the company against serious loss." I consider this very sound advice. They also refer to the fact that different gases produce different results in the diaphragms; that some gases leave a sticky condensate in the meters, and as this condensate comes in contact with the air it becomes thick, causing the valves to drag and operate with difficulty. They therefore point out that it is most important that the inlet and outlet of a meter should be capped-off immediately it is disconnected, so as not to permit the air to come in contact with the interior mechanism. Further than this, they say: "It is unquestionably bad practice to remove a meter from the district and allow it to remain in the shop for any length of time before re-fixing." And, I might add, worse still to leave the meter standing in the open. Various hints are given as regards the location of meters, which should not be placed, for instance, where they can act as condensers—where either the front or the back is subjected to draughts or extreme variations in temperature. Some of these points are, perhaps, rather elementary; but from my own experience of the condition in which meters are received from some undertakings, they are well worth reiterating, and should certainly be inculcated in the minds of gas companies' fitters.

Mr. D. T. LIVESEY (East Grinstead): May I ask if the Committee have considered the question as to whether there is any real objection to the meter connections being standard to the ordinary size of the tubing? It would be a great help if the connections to gas-meters were the same as the ordinary connections of the piping.

Mr. H. KENDRICK (Stretford): The reports of the Committee on Meters are serious reading, and will repay close study. The lack of suggestions made, however, is a blot. It is quite certain from the text that the lower quality of gas supplied during the past few years, coupled with more and new impurities, is largely responsible for the increased destruction of both dry and wet meters, particularly the substitution of blue water gas for carburetted water gas. I have reports from my laboratory that indicate not only the presence of SO_2 in the district meters, but its terribly destructive action in wet meters when the protective paint has been removed. On the far side of the room there is a meter which was supplied to us by a well-known maker in Lancashire, in 1916, which was used continuously for five years, and has just been brought in. There is the front case of it, and you will see evidence of destruction there which is more than alarming. In this particular case, when we opened the meter, we found the drum was completely coated with a deposit that was of a crystalline nature, brown in colour, and consisted of about 80 p.ct. of mixed ferric-oxide and ferric-cyanides. Mr. Taplay, apparently, relies on the report on chemical action for the explanation of the destruction. But in some correspondence he has admitted the probability of another source—viz., voltaic electricity. In a wet meter we have all the elements necessary—two dissimilar metals and an acid liquid, the strength of the acid or current produced does not matter. The following are extracts from a work dealing with electro chemistry: "The chemical decomposing action of a current is constant for a given quantity of electricity." . . . "Provided there are no disturbing secondary actions the amount of electro decomposition is not affected by the

strength (or intensity) of the current, the time the current is passing, the concentration of the solution, the nature of the dissolved substance, nor by the temperature."

The accuracy of the law is stated to have been established for currents so small that a century "would be required for the separation of a milligram of hydrogen." In the electro chemical series, tin, lead, antimony, and copper are all negative to iron; so that in a depositing vat iron could be electro deposited on either of the other metals, and a current in a cell would flow from the iron to the tin, &c., but outside from the tin to the iron. All these conditions are found in a wet meter. The water in a wet gas-meter containing acids, such as CO_2, SO_2, SH_2, and Cy, is sufficiently acid to set up electric energy; and it is quite easily shown that a voltaic cell capable of giving quite an appreciable current can be constructed from a plate of tin and iron in a cell through which a constant stream of CO_2 is passing. In this cell the iron is dissolved, rusting occurs, and the iron rust is deposited on the tin plate in the form of a crystalline mass. The effect of this accelerated corrosion is referred to by Mr. Grace Calvert in the 1915 "Transactions" (p. 125), and in the "Gas World" for July 31, 1920, p. 92, in a paper by Wm. D. Richardson on the Corrosion of Iron and Steel, and by Mr. James Aston before the American Electro Chemical Society—see abstract in the "Journal of the Chemical Society" for May, 1917.

We, at Stretford, have found not only cast-iron drum cases destroyed, and the iron dissolved and softened until it can easily be cut with a knife, but also a great many drums thickly coated with a brown crystalline deposit consisting mainly of ferric oxides and cyanides. Had this been chemical action alone, the deposit would not have been an even one completely covering the drums, but either a gelatinous or granular deposit in the bottom of the drum case. It is quite evident, therefore, that this action is more than chemical, and adds only one more to our difficulties in dealing with the matter. Our notes show that the meters generally attacked are those supplied since 1912; most of them being dated 1915 and 1916. Inquiries of the founders resulted in the statement that the metal used ten years and more ago was best Middlesbrough pig; while during the war years a mixture of any pig that could be obtained irrespective of purity. Iron containing excess of impurities and foreign matter will be attacked and destroyed much more rapidly than pure iron. Examining a large number of cases, we found the compounds or paints used in coating the interior were not so permanent in later years as in the earlier periods. It is quite evident, therefore, that either the meters must be differently constructed or the iron coated by a more acid resisting material than is used now, such as lead or tin, if gas of the same composition is to be sent out as at present. I have been told that an enamel is on the market that is practically indestructible under all known conditions, and is being tried by one firm. Mr. Taplay and Mr. Parkinson in a letter say truly that palliatives are not a remedy. This being so, we must either remove from the gas those substances that give rise to the trouble, make the meters capable of resisting the chemical and voltaic electrical action, or bear the expense of present heavy repairs.

Mr. THOMAS GLOVER (London): I will not keep you for more than a few moments, but I should just like to make one or two comments with regard to the report. I think it is now seven years since this Committee started its work; and for one who has been connected with it from the beginning, it is of the greatest possible interest to find that the research which started in connection with meters only has extended its field and has covered such a wide ground as it is doing now, bringing in questions of corrosion of plant, mains, and services. Really it does show, I think, one thing, and that is that the trouble which has been experienced has been due to the presence of certain compounds—sulphur compounds and cyanogen compounds—in the gas, which have had a far-reaching effect beyond what anyone anticipated at the time the inquiry started. As the President has told you, Mr. Taplay's researches and his latest suggestion for dealing with the removal of these impurities, are not likely to be the least beneficial effect of this inquiry. After all, it originally was only, I think, intended to direct attention to the fact that in the gas-meter, whether wet or dry, we have an instrument on which the whole of the gas industry of this country depends for the very great bulk of its revenue. Therefore these instruments (for after all they are instruments) are worthy possibly of more attention than they have had in the past. I will only just refer to one other topic if I may, and that is the spraying of meters. A great deal of attention has been given to this, and it has been referred to in, I think, at least the previous two reports. I think I am right in saying that the question of spraying was originally introduced under your auspices, Mr. President, and the Company with which you are connected, with the idea of softening the leather fabric of the diaphragms in dry meters, and cleaning the deposit from the valves; and unquestionably in meters that have been fixed and used for some time, it has had that effect. There are some doubts in the minds of many members of that Committee as to whether spraying, especially in the case of new meters, is altogether beneficial. It may, for instance, go a good deal further than affecting the diaphragms and valves. There are signs in some quarters now that excessive spraying may have an effect on the stuffing of the stuffing boxes of the meters, and if it is not an impertinence to say so, I would just sound that note of warning. You may cure your diaphragm troubles; you may cure your valve troubles; but it is more than likely that excessive spraying is the cause, and will be increasingly the cause in the future, of leaky meters owing to the action of these lighter oils on the stuffing in the stuffing boxes. I think, if spraying is done, some attention might be given to the possible use of heavier oils than have been tried up to the present, because the beneficial effect of spraying, if anything, will be found in the end in the coating which it will give to any surface in the mains, plant, and meters with which it comes in contact. I would just like, as one of the Committee, to say that there is nothing in this report, and there has been nothing in the observations so far, to indicate what a great debt of gratitude the whole of this industry will owe to you, Mr. President, and the Company with which you are connected, for the facilities which have been put at its disposal, and for the services of Mr. Taplay, and I think originally Mr. Parkinson. This meeting, I fancy, hardly realizes that the valuable results which will come from this inquiry are very largely due to the President and due to his Company through his great influence.

Mr. J. P. LEATHER (Burnley): I should like to refer to one thing in the report. In the fourth section it says that the Committee have had under consideration an amendment of the Sales of Gas Act. I should like to draw attention to one point, because I do not know to what extent it is known generally that the original Sales of Gas Act had to be adopted by Justices or local authorities within a certain length of time. If they did not do it then, they cannot do it now. I recently went to some considerable trouble with the idea of getting a local office for the testing of meters, but the Board of Trade said it was impossible because the Sales of Gas Act was not adopted by the Lancashire Justices in 1861 or some such date as that. There has been correspondence between our Town Clerk and the Board of Trade on the matter; and this seemed to me rather a peculiar state of affairs, because it would be a great advantage to us to have a local testing office. We have no examining office for a good many miles, and it would reduce the cost of inspection if we could have a local one. I would therefore just mention that if the Committee is going any further into the question of the amendment of the Sales of Gas Act, they might bear that in mind. While I am on my feet, I should like to say how interesting the report is in many other ways.

The report was adopted.

The PRESIDENT: I should like to make a recognition of the very kind remarks of Mr. Thomas Glover with regard to the work that has been done on this matter of spraying and with regard, generally, to the inquiries into the causes of corrosion of meters and mains by my Company. It is quite true that the information obtained was placed at the service of the industry generally; but of course we always recognized that in dealing with these matters we are dealing with ourselves at the same time, so that although we are delighted to give the whole of the gas industry the benefit of what we can do, it is not altogether an unselfish matter. We are dealing with our own affairs in the first place. At the same time I do say this—that my Directors generally, and the staff of the Company generally, are always prepared to take part in whatever work they can which will improve knowledge of matters connected with either the manufacture or the distribution of gas. We have got a thoroughly qualified staff in the Company, and they are encouraged, and they certainly respond to that encouragement, to do all they can to throw light on the details of manufacture and other matters connected with gas-works administration which at the present moment are in doubt.

Mr. P. S. HOYTE (Plymouth): If I am in order, before this matter is quitted, I should like to mention the reference at the conclusion of the report to the new process for the removal of hydrocyanic acid from gas. I hope, and we all do, that the Committee are going to continue their labours; but I should be glad to know if, when they are in the position to confirm or otherwise the satisfactoriness of this new process, they will give it to the technical members of the industry through the Press, and not wait until they have completed another year's labours. The matter is such a vital one for all of us at the present moment, that if there is a process for the removal of this most vicious (if I may so describe it) compound in our gas, I hope we shall be put in possession of the facts by the Committee at the earliest possible moment.

The PRESIDENT: I think we can promise that. We have made several experiments at our Bow Common Works on the removal of hydrocyanic acid by chalk and have gone away from the purely laboratory experiment to an experiment on a larger scale in our works. Although it is of recent inauguration, we have achieved a very considerable measure of success; and I will make arrangements that information, which will be in the nature of a report on progress, shall be given to the industry by some means either through the Technical Press or by other means. Going back for a moment to the point Mr. Leather made with regard to testing, it is a most difficult and inconvenient and expensive matter to be sending meters long distances for testing. The Committee have this in view and are endeavouring to deal with the matter so as to ameliorate these conditions.

INTERNATIONAL COMMISSION ON ILLUMINATION.

Report of Proceedings at Meetings held in Paris, July 5 to 8, 1921.

By ROBERT WATSON, of Doncaster, Delegate of the Institution.

By way of preface, it may be well to recall the historical development of the International Commission on Illumination, which was constituted in August, 1913; and to this end some particulars are briefly extracted from the article in the "Revue Générale de l'Electricité," of July 2, 1921.

At the International Congress of Gas Industries held in Paris in connection with the Universal Exhibition of 1900, it was decided that, in the interests of producers as well as consumers of gas, an International Commission on Photometry should be formed for the purpose of determining rules to be followed in testing incandescent gas lighting. The Commission thus created consisted of representatives from Great Britain, France, the United States of America, Italy, Germany, Austria, Belgium, Holland, and Switzerland. This Commission held their first meeting at Zurich in 1903. At this meeting, the Commission recommended that investigations should be made as to the comparative value of the Hefner, Carcel, and Pentane lamps. The following congress of the International Photometric Commission was held, again in Zurich, in the year 1907, when the communications and discussions were more particularly directed to the question of comparative values of the above three standards. On this occasion, the suggestion was advanced that the possibilities of the Violle platinum primary standard should be investigated. The subsequent session of the International Photometric Commission took place in Zurich in 1911, when the papers submitted showed the increased interest taken in the general subjects of photometry and illumination.

In view of the fact that questions of common interest to both gas and electrical engineers were raised at these meetings, it was decided to ask National Electrical Associations to nominate delegates to the Commission from the countries already taking part. This decision led to the necessity of re-organization, and it was arranged that the fourth session of the International Photometric Commission should be devoted to the discussion of new Statutes. The session was held in Berlin in the year 1913, several days before the meeting of the Electric Technical Commission, so that members representing both interests could take part in the discussion. Statutes were adopted by representatives, some forty-seven in number, of technical societies concerned in the lighting industry in the following nine countries: Great Britain, France, United States, Italy, Germany, Austria, Belgium, Holland, and Switzerland. The International Commission on Illumination was thus formally constituted for the purpose of studying all matters connected with lighting and the sciences related thereto, and also of establishing by all appropriate means international agreement on questions of illumination generally.

A Committee on Illumination was to be formed in each country, consisting of representatives of technical bodies connected with lighting industries, and also of the National Physical Laboratory, if one existed. These Committees were to nominate delegates to the Commission as the major body; the more important technical societies by agreement appointing their own representatives from the national Committee. The total number of delegates of a country was fixed at ten.

The Executive Committee of the Commission was to include the President, three Vice-Presidents, Secretary, Treasurer, and two representatives of each country. The President, Secretary, and Treasurer were responsible to the Executive Committee for the good management of the affairs of the Commission.

In voting, each country affiliated to the Commission had the right to one vote only, whatever the number of delegates. Although English and German could be used in discussion, French was regarded as the official language for resolutions and report of proceedings.

The Officers appointed at the 1913 Congress were as follows: President, M. Th. Vautier; Vice-Presidents, Dr. Bunte, Dr. Hyde, and Dr. Kusminsky; Secretary, Mr. C. C. Paterson (of the English National Physical Laboratory). As a matter of record, it may be stated that the British delegates at this important conference were Mr. W. J. Butterfield, Dr. H. G. Colman, Mr. W. Duddell, Mr. K. Edgcumbe, Mr. L. Gaster, Mr. Le Maistre, and Mr. C. C. Paterson.

The British National Committee on Illumination subsequently formed is comprised of not more than five representatives of the Institution of Gas Engineers, of the Institution of Electrical Engineers, and of the Illuminating Engineering Society respectively, and not more than two from the National Physical Laboratory.

The second session of the International Commission on Illumination which, but for force of circumstances, would have been held in 1916, took place in Paris on July 5, 6, 7, and 8, 1921. This was attended by delegates from the National Committees of Great Britain, the United States of America, France, and Italy, and single representatives from Belgium, Switzerland, and Spain.

The British representatives were Mr. K. Edgcumbe, Institution of Electrical Engineers (Chairman of the British National Committee), Mr. C. C. Paterson (Hon. Secretary and Treasurer to the Commission), Mr. A. P. Trotter, Mr. L. Gaster (both of the Illuminating Engineering Society), Mr. J. W. T. Walsh, Dr. E. H. Rayner (both of the National Physical Laboratory), and Mr. R. Watson (Institution of Gas Engineers).

At the opening meeting, M. Th. Vautier, the President of the International Commission on Illumination, expressed his thanks to the Minister of Public Works and to M. the Senator Dausset, representing the Municipal Council, for their presence and interest in the congress. He recalled the fact that important results had been obtained since 1900, and paid tribute to the work of various investigators. The programme of research instituted by the Commission was proof, among other evidences, of its activity; and the reports presented at the present session were of the greatest interest.

Words of welcome were addressed to the delegates by M. Dausset (in the name of the City of Paris and of the Commission of Gas Control in that City), and from the Minister of Public Works.

The President pointed out that a report of work done since the last session (as prescribed by the Statutes) had not, by reason of events, been made. In the negotiations on the subject of invitations to the present congress, it had been decided not to exclude, but to ignore, the Central Empires.

Mr. C. C. Paterson then presented a statement of accounts covering the period from 1913 to May last. This showed receipts as follows:

Subscriptions, 1914—		
U.S.A.	£50 0 0	
Italy	49 11 1	
France	49 10 8	
Germany	48 18 8	
Great Britain	50 0 0	
Holland	47 9 3	
		£295 9 8
Interest accrued 1915 to April, 1921.		53 18 6
		£349 8 2
Expenditure—		
Postage and petty cash expenses		£3 18 11
Salary to paid Secretary		50 0 0
Secretarial expenses		8 16 0
Expenses of 1913 Meeting of Commission		80 16 4
Balance		199 16 11
		£349 8 2

Mr. Paterson stated that the services of a paid Secretary had, for the time being, been dispensed with, in order to conserve finances. When the present session was decided upon, he had obtained the help of Mr. Walsh, of the National Physical Laboratory, to whom were due their thanks.

The Commission then ratified the nomination of two Committees proposed by the Executive Committee at a meeting on the previous day for the purpose of facilitating the proceedings, viz.:

Editing Committee.—English Language, Mr. K. Edgcumbe, representing both the United States and Great Britain.

French Language, MM. Laporte and Blondin.

Committee on Units and Definitions.—Messrs. Trotter and Walsh (Great Britain), a Belgian representative (to be appointed), Hyde and Kenelly (U.S.A.), Blondin, Fabry, and Laporte (France), Bordoni (Italy), and Filliol (Switzerland).

The Commission proceeded to the discussion of the British proposal for the official adoption as the international unit of candle power of the "international candle" as defined by the three national standardizing laboratories of France (Le Laboratoire Central de l'Electricité), Great Britain (National Physical Laboratory), and America (Bureau of Standards) in 1909, and subsequently preserved by these laboratories.

There was some discussion, during which the President voiced the view that the last six words should be eliminated, considering that the unit should not be based on anything variable such

as an electric incandescent lamp, but rather on something like the platinum standard. Stress, however, was laid on the fact that the three national laboratories were in agreement as to the maintenance of the standard by means of electric incandescent lamps which could be reproduced; and it was essential that this standard should be preserved by them.

The proposal was ultimately adopted unanimously, with the following modification of the concluding sentence: "This unit has been preserved by means of incandescent electric lamps by these laboratories, which remain charged with its preservation."

The following papers were next submitted, *résumés* being in each case given:

"Report on Photometric Quantities and Units." By Prof. André Blondel.

"Photometric Definitions and Units." Presented by Mr. J. W. T. Walsh on behalf of the British National Committee.

"Report (dated 1918) on Nomenclature and Standards." By the Illuminating Engineering Society of the United States.

"Modification of Conventions Relating to Photometric Standard Units." By the Italian Committee.

M. Blondin gave a digest of the first-named paper. M. Blondel had, at the International Congress of Electricians at Geneva in 1896, proposed the first scheme of definitions of photometric quantities and units; and this, adopted with some modifications by the congress, had served as the base of the more detailed system elaborated by the American Society of Illuminating Engineers. The characteristic elements of the system were the consideration of luminous flux as the fundamental quantity in photometry, and the definition of the corresponding unit—the lumen. The task of the present Commission was not so much to revolutionize old methods as to definitely establish order in scientific notions generally accepted to-day, and to furnish practical and sufficiently numerous definitions of all the quantities. M. Blondel dealt in some detail with the propoals of both the American and British Committees, and, in discussing the differences in photometric systems and expressions obtaining in various countries, emphasized the desirability of avoiding purely national and adopting international terms.

M. Blondin pointed out that the author was practically in accord with the American and English Committees as to the principal quantities; his views only being different so far as certain secondary quantities were concerned, which could be discussed in the interval between the present and the next session. It was remarked that the definition of quantities and that of units were not necessarily parallel; for a unit could only be defined in terms of a standard capable of representing it. This was why the fundamental unit could be that of luminous intensity; while the definitions of quantities could be founded on theoretical considerations following the most logical order. From this point of view, all appeared to-day to be in accord as to the adoption of the flux of light as the fundamental unit of photometry.

M. Blondin said the author agreed that from flux the series of definitions could be established; and he therefore commenced his definitions with that of "luminous flux," with the lumen as the unit, and proceeded with "intensity" and its unit equal theoretically to one-twentieth of the Violle standard, and represented by the international candle. He followed with "illumination" deduced from flux, and expressing itself in lumens per square centimetre (phot) or in lumens per square metre (lux).

The paper included a table in French and English of photometric quantities, symbols, units, and abbreviations. The speaker stated that in France some of the latter had been fixed by law.

Mr. Walsh, in dealing with the report of the British Committee, said they considered that the two definitions on which all others should be based were those of luminous radiation and luminous source. Luminous radiation was the power emitted by a luminous source considered from the point of view of its action on the eye. The word "flux," used to represent a rate of flow, was not employed, since in the English language one did not habitually attribute this sense of rate to the word flux. The radiation from diverse sources being practically constant, the British Committee suggested the employment of the lumen as a unit of luminous radiation, without taking into account the idea of time.

Emission or reception of luminous radiation was, of course, a rate of emission or reception of luminous energy, and therefore analogous to a power. This idea was brought out in the term "luminous power," proposed as a substitute for what had often been termed in the past "luminous intensity." The term "candle power" in their proposals had been retained as an alternative to "luminous power" not only as having the sanction of continued use, but also because it involved the correct notion of power, and linked the name of the abstract quantity to the name of the concrete unit—the "candle." The term "luminous intensity" had been discouraged, as there was now a tendency to restrict the word "intensity" to a ratio in which the denominator was an area.

Illumination was the rate of reception of luminous energy over a given area—*i.e.*, the reception of luminous radiation by that area. The metre-candle was thought preferable to the lux as the unit of illumination, since it was analogous to the foot-candle, which was more or less self-explanatory. There was no objection to the alternative use of the word "lux" to denote the unit.

In addition to the above principal quantities, the British report included definitions of brightness, efficiencies, reflection, absorption, and transmission; and these Mr. Walsh briefly dealt with.

Dr. Kenelly presented the American report, and pointed out that their propositions were generally similar to those already advanced. He considered it very important to obtain and record agreement on the fundamental questions without being delayed by divergences in detail.

M. Bordoni, in dealing with the Italian report, remarked that they had been faced with several important questions, especially those relative to the order of photometric quantities with the method of deriving one from the other; and to that of photometric units with the definition of standards of units, one having been defined. In the consideration of photometric quantities, and then of those relating to energy, a parallelism would be found between them; and a table could be made of photometric and energy quantities passing from one series to the other by means of a special physical co-efficient—a function of wave length—to which the name visibility was provisionally given. The co-efficient was the liaison between the photometric quantity and the wave length, which was not a photometric quantity; and it would appear desirable to agree the two series.

While the definitions of the greater number of photometrical quantities could be made in a manner comparable to those of physical quantities, the photometrical quantity of intensity did not appear to be definable in a similar way. The discussion on standards seemed to indicate that the unit of intensity did not fulfil its *rôle* satisfactorily, since it could only be defined mathematically if its source were a true point. The choice, perhaps, remained between the unit of flux and that of illumination. The latter would be preferable, as it did not present the difficulty referred to.

Dr. Kenelly remarked that, in the reports of both M. Blondel and the American Committee, the three chief quantities—flux, intensity, and illumination—were the same. If they were able to agree as to the maintenance of these three units, they would arrive at the desired end. Having briefly referred to the British proposals, he thought that the different propositions might be reconciled by a small Technical Committee. This suggestion was accepted, and a small International Committee appointed. The result of their deliberation was reported at a later meeting, when, after considerable discussion, the following definitions and units were approved and adopted.

[NOTE.—French being the official language of the Commission, in the report the text is given in the original. An official translation is not yet available; but the translation below follows in the report the French text of the definitions and units.]

Luminous flux is the rate of flow of radiant energy evaluated with reference to visual sensation.

Although luminous flux must strictly be defined as above, it may be regarded for practical photometric needs as an entity, since the rate of flow may for such purposes be considered constant.

The unit of luminous flux is the Lumen. It is equal to the flux emitted in a unit solid angle by a uniform point source of one international candle.

Illumination.—The illumination at any point of a surface is the luminous flux density at that point, or, when the illumination is uniform, the quotient of the flux by the area of the surface.

The practical unit of illumination is the Lux. It is equal to one lumen per square metre, or it is the illumination at a surface of a sphere of one metre radius due to a uniform point source of one international candle placed at its centre.

In consequence of certain recognized usages, illumination can also be expressed by the following units: Using the centimetre as the unit of length, the unit of illumination is one lumen per square centimetre, and is called the Phot. Using the foot as the unit of length, the unit of illumination is one lumen per square foot, and is called the foot-candle.

1 foot-candle = 10·764 Lux = 1·0764 milli-phot.

The Luminous Intensity of a point source in any direction is the flux per unit solid angle emitted by the source in that direction. (The flux from any source of dimensions which are negligibly small by comparison with the distance at which it is observed, may be treated as if it were emitted from a point.)

The unit of Luminous Intensity is the International Candle agreed by the three national standardizing laboratories of France, Great Britain, and the United States of America in 1909.

This unit has since then been preserved by means of electric incandescent lamps by these laboratories, which remain charged with its preservation.

The debate which took place on the above resolutions was principally devoted to the proposals of the British Committee: (*a*) That the word "flux" should be replaced by luminous radiation, which did not involve a conception of the time element;

and (*b*) that "luminous power" should be adopted instead of "luminous intensity," the former being more in keeping with established expressions, such as candle power.

The first point was compromised by the inclusion of the sentence indicating that flux may be regarded as an entity; the rate of flow being considered invariable.

The second suggestion caused greater difficulty, in consequence of the different significance given in various countries to the technical words "power" and "intensity." French being the official language, the expression "intensity" was retained; it being left to the United States of America and Great Britain to add their own explanatory notes to the translation.

Primary Standards of Light.—A report on this subject by Mr. E. C. Crittenden, of the Bureau of Standards, was presented by Dr. Hyde. This gentleman pointed out that the paper indicated the conditions under which the American National Committee had considered the question of an international light unit, and referred to the agreement of the American, French, and British national laboratories as to the maintenance of the standard by electric lamps; these lamps fulfilled the desired requirements of constancy, precision, and reproducibility.

Mr. Crittenden discussed the present trend of opinion regarding primary standards. Recent research agreed as to the possibility of fixing the standard in terms of the brightness of a perfect black body. He described several investigations made in the United States with the use as a black body of a platinum wedge electrically heated to the melting-point.

The practical conclusion of the work was that one could adopt provisionally for the brightness of a black body, at a temperature of 2077° absolute, the value of 70·2 candles per square centimetre. This temperature is that at which the black body has the same colour as the electric lamps used by the national laboratories. The conclusions were not, perhaps, definite; but their publication would stimulate other experimentalists, and after further investigations it might be possible ultimately to fix the primary standard of light.

The discussion dealt more particularly with the method of measuring the temperature and its accuracy. Reference was also made to investigations at present in hand by M. Fleury of the radiation from melting platinum.

The following papers were contributed on "Heterochromatic and Physical Photometry," and were taken together for the purpose of report and discussion:

"Heterochromatic Photometry." Two papers respectively by M. Ch. Fabry (France) and Mr. E. C. Crittenden (U.S.A.).

"Use of Light Filters in Heterochromatic Photometry." By Mr. A. H. Taylor, of the Nela Physical Laboratory (Cleveland).

"Suggestions for International Study of the Properties of the Normal Eye." By M. Bordoni (Italy).

"The Relative Visibility Function and the Mechanical Equivalent of Light." By Dr. E. P. Hyde, Director of Research, National Lamp Works of the General Electric Company.

"Recent Developments in Physical Photometry." Prepared by Mr. Enoch Karrer for the National Committee of the International Committee on Illumination. Taken as read.

M. Fabry stated that his communication was intended as a general statement of the progress made in heterochromatic photometry. He pointed out that there were four methods of valuation: (1) By equality of illumination, where the observer essays to allow for the difference of the colour of the two screens compared, and to note the moment when these appear to be equally illuminated. (2) By equality of visual acuity, two illuminations being regarded as equal when they allow the same details to be perceived—those details which give the same value for practical purposes. (3) By flicker measurement, whereby on the same field two rays are compared alternately, the illumination being considered equal when the impression of flicker disappears. (4) By the critical frequency method. The photometric field only contains one screen on which illumination is periodically interrupted and displaced by darkness. If the frequency of eclipse is increased, a critical frequency is reached when the flicker disappears. The more feeble the illumination, the lower the frequency. Two illuminations are regarded as equal if their critical frequencies are the same.

The first and third methods only permitted of precise measurement, and were used in modern research. From recent investigations, it seemed that the equality of illumination method was the most sensitive when colours approximated, and the flicker method when they were distinctly different. All colour comparisons could be affected in certain cases by the Purkinje phenomenon; and industrial or practical photometrical measurements should be made under conditions where this does not occur.

M. Fabry, in his paper, dealt with the question of the sensibility of the eye, and then in detail with the methods which had been, with more or less success, practised in heterochromatic photometry. The difficulty and uncertainty of measurements based on physiological optics was acknowledged, and a change to physical methods, with data of the relative visibility curve and of the mechanical equivalent of light, was probable.

Dr. Hyde, in presenting Mr. Crittenden's paper, referred to the author's review of the different methods employed in heterochromatic photometry, and to the two methods practised in the United States—the flicker and equality of brightness methods. The ratio of the brightness of two lights differing in colour was not a definite single valued quantity, but depended upon the conditions of observation, as well as the characteristics of the individual observer's eye. It is necessary to specify the size and brightness of the photometric field, and also to include observations by a sufficient number of individuals to approximate the results of these to a normal observer. The two methods referred to differed in regard to all these items, as well as in the fact that in one the lights were viewed simultaneously, and in the other alternately. Mr. Crittenden referred to the photometric fields regarded as respectively suitable for each method of measurement, and stated that there was much difference of opinion as to the value of flicker and direct comparison methods.

Dr. Hyde remarked that it was felt in the United States that the determination and measurement of light sources of different colours should be reserved for laboratory research, and that in ordinary work comparison should be kept to light of the same colour; difference in colour being eliminated by, for example, absorbent media.

Following a brief reference by Dr. Hyde to Mr. A. H. Taylor's paper, and general remarks by M. Bordoni, Dr. Hyde proceeded with a *résumé* of his own contribution on the "Relative Visibility Function and the Mechanical Equivalent of Light." He stated that the luminosity curves obtained by the flicker and direct comparison method of photometry were clearly different. It was important that the visibility function should be determined by the two different methods. These are described in the paper, which includes a table and chart showing the comparison in detail of the various determinations of relative visibility.

The evaluation of the mechanical equivalent of light involved the problem of heterochromatic photometry—either in the measurement of the luminous flux of monochromatic radiation, or in the use of the visibility curve in the computation from the measurement of the integral luminous flux from some source of known energy distribution. The various determinations therefore grouped themselves under two heads—those made by (1) flicker photometry and (2) direct comparison photometry. It would seem that the value of 0·00160 watt per lumen for the mechanical equivalent of light on the basis of flicker photometry might be considered as having very substantial support for investigation. The direct comparison method indicated 0·00150 watt per lumen.

After a short discussion, Dr. Hyde suggested that a Committee of three be appointed to collect relative results and data in heterochromatic photometry before the next session of the Commission.

The subject of industrial and school lighting, with legislation governing same, was dealt with in the following papers:

"A Short Summary of Developments on Industrial Lighting." By Mr. L. Gaster.

"Lighting Legislation in the United States." By Mr. L. B. Marks.

"A Method of Comparing Lighting from a Subjective Point of View in Workshops and Factories." By Prof. A. Blondel.

"Lighting of Workshops and Factories." By Prof. C. M. Gariel.

Mr. Gaster stated that the aim of his report was to recommend good lighting in factories for the purpose of preventing accidents. He gave an historical sketch of the subject, and of the progress made in different countries. He thought it desirable that legislation should be effected to govern the lighting, ventilation, and heating of factories, and that to this end a Special Committee should be established to collect and compare the data of different countries.

The question of school lighting included in Mr. Marks's paper should also be considered. Co-operation was wanted; and ultimately, it was hoped, an "international code" of industrial lighting would be established.

The report of Mr. Marks furnished particulars of the code and specifications for lighting factories, mills, and other workplaces as prepared in 1915 by the American Illuminating Engineering Society, and already used as a basis for legislation by several States in America. The code was a safety code; and the minimum illumination specified was for safe lighting, and not the minimum requirements for efficient lighting for productive purposes.

The code was under revision by the American Engineering Standards Committee. Pending this work, the proposed revised rules were given tentatively as follows:

CODE OF LIGHTING FACTORIES, MILLS, AND OTHER WORK PLACES.

RULES.

General Requirement.—Traversed spaces, during the time of use, and work in process, shall be supplied with light in accordance with the following rules:

Rule 1.—*Intensity Required.*—The illumination maintained shall be not less than given in the following table:—

	Minimum Foot-Candles. On the Space or at the Work.
(*a*) Roadways; yard thoroughfares	$\frac{1}{50}$
(*b*) Storage spaces; aisles and passageways in workrooms, excepting exits and passages leading thereto . .	$\frac{1}{4}$
(*c*) *Where Discrimination of Detail is Not Essential* . .	$\frac{1}{2}$
Spaces such as hallways, stairways, exits, and passages leading thereto; toilet rooms; elevator cars and landings. Work, such as handling material of a coarse nature; grinding clay products; rough sorting; coal and ash handling; foundry charging.	
(*d*) *Where Slight Discrimination of Detail is Essential.* .	1
Spaces such as stairways, passageways, and other parts of power plants where there are exposed moving machines, hot pipes, or live electrical parts. Work, such as rough machining, rough assembling; rough bench work; rough forging; grain milling.	
	Maximum Foot-Candles. On the Space or at the Work.
(*e*) *Where Moderate Discrimination of Detail is Essential.*	2
Work such as Machining; assembly work; bench work; fine core making in foundries; cigarette rolling.	
(*f*) *Where Close Discrimination of Detail is Essential.*	3
Work such as fine lathe work; pattern making; tool making; weaving light coloured silk or woollen textiles; office work; accounting; typewriting.	
(*g*) *Where Discrimination of Minute Detail is Essential* .	5
Work such as watch making; engraving; drafting; sewing dark coloured material.	

Rule 2.—*Avoidance of Glare; Diffusion and Distribution of Light.*—Lighting, whether natural or artificial, shall be such as to avoid glare, objectionable shadows, and extreme contrasts, and to provide a good distribution of light. In artificial lighting systems lamps shall be so installed in regard to height, location, spacing, and reflectors, shades, or other suitable accessories as to accomplish these objects.

Bare light sources, such as exposed lamp filaments or gas mantles, located within the ordinary field of the worker's vision, are presumptive evidence of glare.

Rule 3.—*Exit and Emergency Lighting.*—The lighting to be provided under Rule 1 in all stairways and exits of factories, and in the passageways appurtenant thereto, shall be connected independently of the regular lighting of the working space. Such lighting shall be supplied so as not to be subject to failure because of the failure of the room or shop lighting from internal causes, and preferably from an independent connection extending back to the main service entrance for the building. In case of unusual danger which may exist on account of type of building, nature of the work, crowded conditions, or lack of suitable exit space, an independent service shall be ensured by connection to a separate source of supply without or within the building.

In the case of school lighting the code issued by the American Illuminating Engineering Society in 1918 has been adopted by a number of municipalities. The code is as follows:

CODE OF LIGHTING SCHOOL BUILDINGS.

Article I.—General Requirements.—When in use, all buildings should be provided, during those hours when daylight is inadequate, with artificial light according to the following articles.

Buildings hereafter constructed should be so designed that the daylight in the work space is reasonably uniform, and the darkest part of any work space is adequately illuminated under normal exterior daylight conditions.*

Article II.—Intensity of Artificial Illumination.—The desirable illumination to be provided, and the minimum to be maintained, are given in the following tables.†

Desirable and Minimum Illumination.

	Artificial Lighting.‡ Foot-Candles (Lumens per Square Foot) at the Work.	
	Minimum.	Ordinary Practice.§
Storage spaces	0·25	0·5– 1·0
Stairways, corridors	0·5	1·0– 2·5
Gymnasia	1·0	2·0– 5·0
Rough shop work	1·25	2·0– 4·0
Auditoriums, assembly rooms	1·5	2·5– 4·0
Class-rooms, study rooms, libraries, laboratories, blackboards	3·0	3·5– 6·0
Fine shop work.	3·5	4·0– 8·0
Sewing, drafting rooms	5·0	6·0–12·0

* Daylight illumination values should be at least twice the values given in the Table, Article II., for artificial lighting.

† The illumination intensity should be measured on the important plane, which may be the desk-top, blackboard, &c.

‡ It should be borne in mind that intensity of illumination is only one of the factors on which good seeing depends.

§ Under the column headed "Ordinary Practice," the upper portion of the range of intensities is preferable to the lower. Where economy does not prohibit, even higher intensities than those cited are often desirable.

Article III.—Shading of Lamps.—Lamps should be suitably shaded to minimize glare. Glare, either from lamps or from unduly bright reflecting surfaces, produces eye-strain.

Article IV.—Distribution of Light on the Work.—Lamps should be so arranged as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensities.

Article V.—Colour and Finish of Interior.—Walls should have a moderate reflection factor. The preferred colours are light grey, light buff, dark cream, and light olive green. Ceilings and friezes should have a high reflection factor. The preferred colours are white and light cream. Walls, desk-tops, and other woodwork should have a dull finish.

Article VI.—Switching and Controlling Apparatus.—Basements, stairways, store-rooms, and other parts of the building where required, should have switches or controlling apparatus at point of entrance.

Article VII.—Emergency Lighting.—Emergency lighting should be provided at main stairways and exits, to ensure reliable operation when, through accident or other cause, the regular lighting is extinguished.

Article VIII.—Inspection and Maintenance.—All parts of the lighting system should be properly maintained, to prevent deterioration due to dirt accumulation, burned-out lamps, and other causes. To ensure proper maintenance, frequent inspection should be made at regular intervals.

The communication of M. Gariel (who is President of a French Commission on the subject) covered the general principles underlying industrial lighting—general and local—both from the points of view of safety and efficiency of work. He referred to the legislation enacted in different countries for the purpose of securing the first, and indicated the good results obtainable by achieving the second. The American code data are included in the paper. The author hoped that the work of the Commission would be successful in educating public opinion as to the importance of the whole matter.

In the discussion, several speakers were of opinion that legislation on industrial lighting should be confined only to safety, and not to efficiency lighting; the latter being a matter of variation according to working conditions and circumstances.

It was proposed that a Committee should be formed to study the question generally, with a view to presenting a report at the next meeting of the Commission.

Two reports were presented by the American Illuminating Engineering Society on "Automobile Headlighting" and "Specifications." These were signed by Dr. C. H. Sharp, as Chairman of a Committee of that Society constituted for the purpose of formulating specifications. The latter had already been adopted by several States. Dr. Hyde, in presenting the reports, stated that this question was regarded in the United States of America as very important, and car manufacturers had formed a Committee for studying the matter. M. Boehm considered this question more important than industrial lighting, since the safety of the public was involved. Mr. Paterson agreed with this view, and added that international regulations were further necessary, so that the lighting of cars made in one country was such as to be satisfactory in any other.

The discussion indicated some difference in practice in different countries; and the opinion was ultimately expressed by the Commission that the regulations for automobile lighting should not be formulated without some international agreement. It was suggested that each National Committee should keep in touch with the authorities proposing to issue regulations; and it was agreed to appoint a Committee, under the presidency of Dr. Sharp, to study and take any necessary steps in the matter.

BIBLIOGRAPHY OF LIGHTING.

The President made a suggestion that a bibliography of lighting be issued each year. This would constitute a useful brochure, in which could be found anything that was of importance for reference.

The question of expense was considered, and suggestions made as to the possibility of utilizing some existent national paper, such as "Science Abstracts," and others.

FINANCIAL SUPPORT.

The Commission considered, and agreed to, the following proportionate annual contributions to cover the expenses incurred between the present and succeeding sessions:

(*a*) Countries with a population of less than 10 millions, £25;

(*b*) Countries with a population of over 80 millions, £200.

(*c*) Countries with a population between 10 and 80 millions, at £2 10s. per million.

The estimated total is £600, equal to 28,000 frs., with rate of exchange at 46.

NATIONAL COMMITTEES.

Proposals were adopted for the formation of National Committees in countries where they had not yet been appointed.

Committees on Technical Subjects.

The following Committees on Technical Subjects were constituted:

Heterochromatic Photometry.—Prof. Ch. Fabry (Chairman), Mr. W. C. Crittenden, and Dr. E. H. Rayner.

Photometric Definitions and Symbols.—M. André Blondel (Chairman), Dr. C. H. Sharp, M. U. Bordoni, Mr. J. W. T. Walsh, and Belgium, Swiss, and Spanish representatives (to be nominated later).

Lighting of Factories and Schools.—Mr. L. M. Marks (Chairman), M. U. Bordoni, Mr. L. Gaster, with representatives from Belgium, France, Spain, and Switzerland (to be appointed later).

Automobile Lighting.—Dr. C. H. Sharp (Chairman). Members to be appointed by National Committees.

Officers.

Officers of the Commission were appointed as under:

President.—Dr. E. P. Hyde.

Hon. President.—M. Th. Vautier.

Vice-Presidents.—M. F. Rouland (France), M. G. Semenza (Italy), and Major K. Edgcumbe (Great Britain).

Hon. Secretary and Treasurer.—Mr. C. C. Paterson, with Mr. J. W. T. Walsh as Assistant Secretary.

Date and Place of Next Session.

It was decided that the Commission next meet in the year 1924, and, as provisionally arranged, in New York.

During the course of the Session the delegates were entertained at dinner by the President and members of the French National Committee; the compliment being returned by a luncheon at which the latter were guests.

The delegates were also invited during one evening to a demonstration and description by M. L. Gaumont of picture films in colours, and of speaking films.

In the course of his explanation of the report, Mr. Watson said: I should like to draw particular attention to the question of factory lighting, in which considerable interest is being taken in all countries. I should like to suggest that wherever data of good gas-lighting installations in factories and workshops are available, they should be furnished to the Committee that has been constituted in this country to investigate the conditions of factory and workshop lighting, which I am sure will be to the interest of the gas industry as a whole. Our electrical friends are interesting themselves considerably in the matter, both in the United States and in France. We, if I may say so, not merely wish not to be left behind in this work, but we should be in the forefront of it. In France, for example, the Society of Electricians have established only recently a Sub-committee for the investigation of forms of industrial lighting, who intend to go, as we were told at the Paris Congress by Prof. Fabry, very thoroughly into the matter; and the data they provide will undoubtedly be used by the Commission. In view of the importance of the subject, I have extracted from the American paper on illumination data which they have suggested, and which, as a matter of fact, have been adopted by many of the States in America for safety lighting. I think the information in the report which is now before you might be useful, not merely for purposes of comparison, but as a guide to our own practice. France and Switzerland are not so much concerned, unfortunately for them, with matters of illumination. We were told by one gentleman present that, owing to the restrictions during the war, when coal was scarcely available, legislation had almost practically prohibited gas illumination. Electricity, of course, depending as it does on water power, had no such restriction; and they have in Italy, I was told, only an output for gas illumination proper of something like 2 p.ct. of their whole output. I mention this because, if we do not maintain our interest in all forms of lighting in this country, we may through other causes have our outputs reduced, and our financial result must inevitably suffer.

After explaining other portions of the report, Mr. Watson said: I should like to say that our reception on the part of our French friends was exceedingly cordial. We received great courtesy from them, and the pleasure of attending their meeting was great from the personal point of view, so that I feel really indebted to the Council for having appointed me their delegate to the conference.

DISCUSSION.

The President: In moving the adoption of this report, I should like, first of all, to remark that it is quite evident, from the able way in which it has been composed and extracted, that we had the right representative on this Commission; and I am sure the thanks of the Institution are due to Mr. Watson for going there, and for giving us in such detail an account of the proceedings of the meeting. As Mr. Watson said, it is a very desirable thing that these various national standards should be merged and modified, so that we may have a standard for the measurement of light, and for other measurements that we have to make, ancillary to the direct measurement of lighting. It has been a great source of confusion for us to have the candle here, in France to have the measurement by another standard, the *carcel*, and in Germany, to have the *hefner*, and so on; and it is all to the good that we should have some international system by which lighting and these details should be measured. It by no means follows—in fact it is quite clear that our interests have certainly not been diminished by the alteration of the standard of value of our gas from the terms of illuminating value to those of calorific value. After all, the purpose of our gas is to be used (and it is so largely used) for lighting, that we know the use of it for lighting can be extended with the study of illumination and the measurement of illumination, so that it will become, not of less, but of greater importance than it used to be. The illumination of factories and workshops has taken-on a much more scientific basis than formerly; and it is quite clear, having regard to the additional interest that is taken in the health of the people generally, and especially the working classes, that this subject of factory and workshop lighting is going to be a matter which must be very closely studied if gas is going to hold its own in factories and workshops as the agent of illumination. Therefore we are much indebted to Mr. Watson, and all the more indebted to him for the details he has given dealing with these particular points. Dealing with the reference to workshop and factory lighting, I think Mr. Watson was referring to the Home Office Report on Workshop and Factory Lighting, which the Council of the Institution has under consideration. They are devoting great attention to it, and are keeping very closely in touch with information coming from sources generally that will enable them to get out a report at an early date. I do not think I need refer in any other detail to the report—Mr. Watson has done it so thoroughly; but I will ask you to discuss the report before putting it to the meeting for adoption.

Mr. S. B. Langlands (Glasgow): I think we have to congratulate ourselves that we have such a man as Mr. Watson in our midst. The work that he has done on this Illumination Commission has been of essential value to the Institution, and I should like it to be understood that Mr. Watson is going to pursue this work further for us in the future. I notice that the next conference is not to be in Paris, but in the United States; and I think that we have to put ourselves in this way, that we have got to send Mr. Watson there to go on with the good work he is doing. The work that has been done on factory and workshop illumination has been of essential value. I notice that the lowest foot-candle allowed in the report is 0·025, and that it goes as high as 5 for efficient illumination. These are good figures, and yet they give you the suggestion that we should go beyond these figures in any work we do. The question of automobile headlights does not concern this Institution very much; but I think we all suffer from that horror, the automobile headlight, and something must be done by automobile designers to eliminate the trouble. It is good to see that they are forming a bibliography of the subject, and I hope we shall have a translation of the French papers. I hope we, as an Institution, will help Mr. Watson in every way, and that we shall have him our permanent representative of this Commission.

Mr. A. I. Phillips (American Gas Association): I have on this particular subject no remarks to make. The matter of illumination in the United States is probably not so acute in the gas industry as it is here. Our standards of quality in the past have been much higher, and I am inclined to believe that the percentage of open-flame burners still in use is much higher than it is in this country. We have, in testing for candle-power, adhered to the standard of the open-flame burner, tested against a standard candle. This, of course, results in higher calorific value of a given candle-power; in fact, our candle-powers have hardly been comparable. The question of illumination with us is much more acute with the electrical industry, for the reason that electricity has displaced other illumination to a far greater extent than it has in this country. Street lighting, for example, in the United States is almost entirely electrical; and to an American the splendid street illumination in Great Britain by gas is, indeed, most interesting. Further than that, I do not know that I can add anything to the discussion on the subject. But, Mr. President, I think, while I have the floor, I should like to extend to you, and to the members of this Institution, the best wishes of the American Gas Association, and wishes for the continued success of the very valuable and interesting work which you are doing.

Mr. J. P. Leather (Burnley): I have pleasure in seconding the adoption of the report.

This was agreed to.

TAR DISTILLATION AND SULPHATE OF AMMONIA MANUFACTURE.

ABSTRACT OF PAPER BY THE SOCIETY OF BRITISH GAS INDUSTRIES.

Accompanied by a Series of Fifteen Foolscap Plates of Detail Drawings.

TAR DEHYDATION AND TAR DISTILLATION,

The Chemical Engineering and Wilton's Patent Furnace Co., Ltd.'s Process.

Plates Nos. 1 and 2.

Though tar dehydration is a simple operation carried out in a simple plant, it is one which provides a product of first-class value in the making and maintenance of roads. The fact that the dehydration can be carried out more economically at the gas-works than elsewhere has made the installation of this simple plant an asset of considerable value. The points first considered in the Wilton plant were safety from fire or danger and economy in labour, fuel, and maintenance.

The crude tar is placed in the feed tank at ground level. A pump, set to run at the quantity of tar to be treated per hour, takes the crude tar from the feed tank and passes it through the economizer, where it becomes heated by dehydrated tar leaving the plant. The heated tar passes on to the coil still, where it is raised to the required temperature, between 140° and 220° C., by a coke-breeze furnace.

A small pressure is maintained on the coil by a relief valve; but when the tar passes the valve, it enters a vapour box at atmospheric pressure. Consequently, the water and light products become vapour, and the tar, dehydrated, gravitates to the economizer and storage. The vapour condenses in a coil, and is collected in a separating receiver in the form of ammoniacal liquor and light oil, which are drawn off as required. The dehydrated tar, slightly cooled in the economizer, is placed in barrels or is pumped to overhead storage, &c.

The complete distillation of tar to pitch, giving creosote and anthracene oil, is carried out by adding pot stills to the dehydrator already described. The combined plant is worked by unskilled labour, as in this system no "frothing" is possible. A further feature is that the pitch is run off in bulk, which reduces the frequency of testing and assures a uniform pitch.

THE DEMPSTER TAR PLANT,

Messrs. R. & J. Dempster, Ltd.

Plate No 3.

The necessity of tar plants in gas-works has grown of late years largely through the demand for dehydrated tar. The plant should be capable of totally distilling as well as manufacturing dehydrated tar. The intermittent system shown will enable both operations to be performed. Consideration must be given to local conditions and lay-out of the plant, and unnecessary pumping of tar and fractions avoided by the free use of gravity for all products, including even pitch where possible. Steam coils should be fitted in all tanks, particularly the tar tank, to keep the contents fluid. The plant illustrated shows the—

- A Preheater
- B Stills
- C Main condensers
- D Secondary condensers for the products from the preheaters
- E Receivers
- F Pitch cooler
- G Pitch beds
- H Creosote settling tanks
- J Oil-tanks
- K Dehydrated tar tank
- L Foul gas collecting mains
- M Breeze burner
- N Tar-pump
- O Overhead service tank

The preheater is not essential; but its use effects a considerable saving in fuel and time of distillation. It recovers heat which would otherwise be entirely wasted, and avoids cooling-down of the still, with consequent strain on the riveted joints. Full arrangements are made for the collection and burning of foul gases, which is essential to a healthy plant. When the plant is used to make dehydrated tar, the preheater is bye-passed so that the vapours go direct to the condenser, and the pitch cooler is shut off and the product run direct into the storage tank.

Hydraulic pressure is used for shaping the still plates; and multiple plates in the top and bottom are not employed unless particularly specified, but made in one. All joints are kept clear of the flues as far as ever possible; and, with the exception of the pitch cooler, the whole of the connections to the still are in the crown. Double coils are used in the condensers, either steel or cast iron.

The setting is solid in construction, fire-brick lined, with protection for the still bottom, and baffles for the circulation of the hot gases. The furnace is arranged to burn breeze with forced draught, with provision also for gas-firing, and a connection for burning foul gases.

THE HIRD TAR DISTILLING SYSTEM.

Messrs. W. C. Holmes and Co., Ltd.

Plates Nos. 4 and 5.

This system, as used for tar dehydration and also for complete distillation, is continuous in action, and is controlled by temperature indications at several points on the plant. The feeds are by gravity throughout, the tar entering from a small tank supplied from a float valve, and the products of either process overflowing continuously to receivers.

The plant for complete distillation consists of three fired stills, or in some cases four, together with accessory heat-exchangers, condensers, &c. Cast iron is used in the construction of all stills liable to corrosion; and the heating surfaces are in a readily replaceable form—*i.e.*, straight tubes.

Plate 4 shows a lay-out of a plant distilling 50 tons of tar per day, or (say) 16,000 tons per annum, the method of working being fully described in the paper.

The heating of the stills is performed by 6 in. diameter tubes, lying submerged in the tar, and expanded into the end plates of the stills. There is, in the case of coke-fired plants, an external furnace; or if gas-fired, a bunsen burner of special design is applied to each tube. The waste gases from the further ends of the tubes are employed in heating the last still, generally along the bottom.

Heat recovery is accomplished mainly in the tar-heaters, which condense the vapours of the successive fractions. Cast-iron coils are usually employed. Further heat-exchange is also obtained between the crude tar and the hot pitch, mainly with a view to cooling the latter.

Typical temperatures of operating would be as follows:

	Deg. C.
Tar entering plant	25
Leaving waste steam preheater	65
Leaving preheater system	135
Leaving first still	245
Leaving second still	310
Leaving third still	295

Plate 5 shows the arrangement of a dehydrating plant of a capacity of 24 tons of crude tar per day, which, as will be seen, is virtually a single unit of the complete set. The still is of strong cast-iron construction; and the process is similar to that outlined for the complete plant.

TAR PLANT.

Messrs. C. & W. Walker, Ltd.

Plates Nos. 6 and 7.

The plant illustrated embodies the latest improvements in tar distillation to once-run fractions (without refining), including dehydration, and shows a plant capable of dealing with about 15 tons of tar per twenty-four hours. The general apparatus comprising the plant consists of the following: Main still, secondary still, condensers, separators, measuring tanks, storage tanks, pitch cooler.

The main still is cylindrical in form, with domed top and dished bottom, and is fitted with man-lid, ball safety valve, pyrometer, tar inlet, and pitch outlet. The furnace is arranged for coke firing; but it can be adapted for burning naphthalene or for firing with crude gas.

The secondary still is of similar construction to the main one, except that the bottom is flat. A specially designed cast-iron coil is fitted in the interior. The fittings on the top are similar to those on the main still; and, in addition, an outlet, with cock, is provided close to the bottom for drawing-off dehydrated tar, which can be used for road-spraying purposes.

The condensers consist of two separate vessels of similar design, each of which is fitted with a serpentine condensing coil. The separators, which are placed immediately below the outlets from the condensers, are fitted with a simple and effective device for separating the water and the condensed oil. The measuring tanks are rectangular in form, and are fitted with canvas screens through which the distillates are filtered. The storage tanks are boiler shaped, and are of such dimensions as allow of ample storage.

The pitch cooler is cylindrical in form, with dished ends. An expansion joint is arranged in the centre, and a large manhole, with swing safety door, is fixed on the top close to one end. The inlet pipe is provided with a stuffing box and gland, to allow for expansion and contraction; and the flow of pitch is regulated by a special quadrant cock. The pitch bay consists of a pit enclosed with brick walls, into which the pitch is run from the cooler, and where it is allowed to set.

The plant is simple to operate and safe in its working, and is capable of producing soft, medium, or hard pitch; but it requires careful supervision.

SULPHATE OF AMMONIA PLANT.

Messrs. C. & W. Walker, Ltd.

Plates Nos. 8 and 9.

The two plants illustrated are of 5 and 3 tons capacity per twenty-four hours respectively; and with each is included a neutralizing apparatus. The principal feature of the still is in the design, which is of such a nature that the interior, by the removal of the cover plates, can be conveniently got at for cleaning-out purposes without dismantling any of the sections.

The preheater is of simple construction, and consists of a circular cast-iron vessel filled with tubes. The liming apparatus comprises two vessels, in one of which the lime is slaked, and in the other thoroughly mixed into milk of lime. The saturator for the larger-size plant is of the self-discharging type; while for the smaller plant it is of the "fishing" type, made of plate lead, properly protected with strong wood casing.

The centrifugal driers are of the "Weston" type, with bottom discharge. For the larger plant the drier is belt driven, and for the smaller plant steam driven. The condenser for the larger plant consists of a series of pipes led backwards and forwards connected at the ends by U bends. For the smaller plant a water-cooled condenser is shown. The cooled gases from the condenser are treated in oxide purifiers, for the abstraction of the obnoxious sulphur fumes before passing into the atmosphere.

The neutralizing apparatus consists of serpentine condenser, blow bottle, air heater, fan, and conveyor-drier. The inlet to the condenser is connected to the still at the top section of the fixed portion, while the outlet discharges into the blow pot; the latter being periodically charged with ammonia condensate, and in which it is diluted. Compressed air is used for spraying the ammonia solution from the blow pot on to the sulphate of ammonia in the centrifugal basket. After the neutralized salt is discharged from the centrifugal, it is passed through a conveyor-drier, where the moisture is driven-off previous to its being discharged into the stores.

The power unit for driving the neutralizing plant consists of a steam-engine for the smaller plant, and a gas-engine for the larger. In the latter case, the gas-engine is also utilized for driving the centrifugal drier.

SULPHATE OF AMMONIA PLANT.

Messrs. W. C. Holmes & Co., Ltd.

Plates Nos. 10 and 11.

Plates Nos. 10 and 11 show respectively in diagrammatic form a complete plant, capacity 3 tons of salt per day, with saturator suitable for hand or ejector fishing, and the essential features of a plant of 10 tons capacity per day with bottom discharge saturator.

The paper is mainly devoted to descriptions in detail of certain features and improvements comparatively recently introduced mainly to fulfil two paramount requirements. No. 1, to economize to the greatest possible extent the consumption of steam, lime, cooling water, &c., and the labour necessary to work the plant. No. 2, to make it possible to maintain full output for the longest possible period of a run, and that without loss of efficiency, or the employment of an undue amount of supervision.

Two types of stills are referred to and described in the paper: The first, the ordinary bubble type of still with removable hoods and external overflows, and the second, the "Wyld" still, which is of somewhat novel construction.

As will be seen from the detail and section on Plate 11, the liquor travels down the column in cascade fashion; there being no constricted inlet or overflow ports. The steam and ammonia vapours, in travelling up the column, are made to pass in a horizontal direction through the film of liquor forming the cascade and across the surface of the liquor contained in the trays. A finely-divided spray is thus formed, facilitating the release of the ammonia from the liquor, and effective agitation of the contents of the trays maintained. Low-pressure or exhaust steam may be used; and the quantity of steam required to strip the liquor is found to be 20 to 30 p.ct. less than that used in the bubble form of still. Large lining chambers are used, fitted with internal devices to ensure thorough mixing of the lime and liquor, and the removal as far as possible of insoluble matter before the lime enters the still.

The Shewring type of constant gravity feed (see detail Plate 11) is a valuable aid in giving greater control over the lime supply.

Alternative types of salt-handling plant are also shown. The plants are provided with suitable apparatus for the production of ammonia vapour for neutralizing purposes, both by impregnating the finished "whizzed" salt with dry gas and by washing with a weak solution during the process of centrifuging.

THE "DEMPSTER" SULPHATE PLANT.

Messrs. R. & J. Dempster, Ltd.

Plates Nos. 12 and 13.

Sulphate of ammonia being one of the important bye-products of a modern gas-works, every consideration should be given to points that tend to economical working. The plant should be of substantial construction to meet the wear and tear factor; and the operator's work requires careful study, for this plant is often tended by a semi-skilled labourer.

The following are important points: Ample still capacity, with maximum agitation and slow travel. Removable sides, and separate still for the fixed ammonia, and of heavy design to meet the stresses owing to the varying temperatures and pressures. The still must be built to provide easy removal of the front plates and internal parts and all the fixed fittings attached to the sides. Constant flow of tar-free liquor. Saturator of thick lead having ample seal. Good capacity of liming plant with pump working slow speed. Large surface in preheater. High temperatures produce good salt. Good area for draining, and properly equipped catch-boxes, and gauges for liquor, steam, &c., with suitable reducing and safety valves. All parts requiring attention easily accessible, and provision throughout for cleaning. All connections should be well supported to ensure free draining, and lead covering provided to catch any drippings of acid or mother liquor.

For Illustration See Plates Nos. 12 and 13.

A Overhead liquor supply tank
B Preheater
C Primary still having liming chamber D at base
E Secondary or fixed ammonia still
F Catch trap for condensed liquor
G Saturator having detachable ammonia pipes
A F Catch-box for acid vapours
R Acid tank
H Cooler. The "devil" liquor is carried to the preheater, and thereby heated, passing through a sealed pipe to the still out-flow
J Purifier
K Spent liquor valve
L Lime settling tanks
M Lime slaking tank
N Cream of lime supply tank
O Drainer and "whizzer"
P Sulphate store. The salt is neutralized previous to storing.

MANUFACTURE OF SULPHATE OF AMMONIA

The Chemical Engineering and Wilton's Patent Furnace Co., Ltd.

Plates Nos. 14 and 15.

The simplest method of obtaining the greatest quantity of the best sulphate of ammonia in the cleanest plant with the lowest maintenance cost is the object aimed at by gas engineers. The competition from abroad and the immediate prospect of a new fertilizer at home have given an impetus to improvement in the quality of sulphate of ammonia.

The Automatic Discharger.

The Wilton plant was first designed by the late Col. T. Wilton, founded on his automatic discharger. The system has been developed for use in the gas industry by the Chemical Engineering and Wilton's Patent Furnace Company, Ltd.

The Wilton plant is made-up of standardized parts into installations specially designed for each works. The plant is one which is continuous and automatic from the inlet of liquor to the filling of bags with anhydrous neutral sulphate of ammonia. The liquor enters by a graduated sight feed, and is raised to boiling-point by the gases from the saturator in a cast-iron tubular heater with expansion joint. The boiling liquor enters the main still near the top, and passes through trays fitted with hoods into a lime chamber to which a constant feed of boiling milk of lime is provided by Wilton's lime pump. The lime chamber is adjacent to the main column, and has a funnel-shaped bottom below the agitator for the settlement and blowing-off of lime grit.

The ammonia is absorbed in a closed saturator to which acid is provided. The sulphate is discharged from the top by Wilton's discharger on to a receiving tray, from which the surplus mother liquor gravitates back to the saturator. When the tray is full of sulphate, a shoot is lowered connecting it to the centrifugal machine, and the slide removed, and sulphate trimmed-down into the "whizzer" by a wooden rake. The remainder of the mother liquor is "whizzed" out, and gravitates straight into the saturator.

The neutralization is carried out by running a charge of about 2 gallons of cold ammoniacal washing liquor through the "whizzer." This ammoniacal solution is made either by concentration and cooling ammonia vapour from the still, or from Wilton's household ammonia generator.

The neutral sulphate is discharged through the bottom of the centrifugal basket into a hopper, from which it feeds into a steam-heated trough by mechanical means, and is stirred in a natural draught of hot air. The dry neutral salt drops out at the end of the trough either into a heap or into bags.

DISCUSSION.

The President: I am sure we are deeply indebted to the Society of British Gas Industries and to Alderman West for bringing before us this excellent book of reference with regard to tar distillation and sulphate of ammonia manufacture. It forms a complement to another very interesting book of reference that was presented to us last year, which, you will recollect, dealt with carbonizing plants; and I am sure we shall find many valuable hints and suggestions with regard to future manufacture as well as current methods of manufacture. There is a little hiatus between the two which, I hope, in course of time,

will be made up. We have jumped clean from carbonization to dealing with tar and selling ammonia; and I am sure it would be nice to have a similar work to the two to which I have referred which would cover the intervening ground. [Hear, hear.] I should be glad to have a good discussion on the various forms of plant that we have had described to us this morning.

Mr. S. A. WIKNER (Newcastle-on-Tyne): First of all, I should like to thank you for giving me an opportunity of contributing to this discussion, because I am only a visitor. This question of tar distillation by gas companies, of course, has been before you for a long time; and it appears that something ought to be done definitely as to the type of plant one should go in for. Complete continuous distillation always has appealed very strongly to scientists. It seems to be the right thing. There should be abundant opportunity for obtaining all the conservation of heat that can be obtained; and it is generally a beautiful process. The tar runs in, and the products come off. When you get to know it, you do not have a great deal of trouble. It is a process that I know has certain definite advantages; but no financial value can be given to them. The principal advantage with the continuous still is that, first of all, it is quite safe. We really cannot say that about the pot still, although it has been in use ever since tar-distilling began. There have not been very many explosions; but there have been some, and there have been, as most of us know, innumerable fires. Also there have been accidents in connection with cleaning these pot stills, and many of them proved fatal. You cannot put a money value to things like that—to cleanliness of works, safety, and freedom from explosion. But when you come to consider the points that you can put a money cost to, I think the continuous process is nowhere near the old-fashioned double-pot still; and I have been in the fortunate position of having long experience of pot stills—a lifetime, although not a very long lifetime. However, all my work in life, until three years ago, was bound up with pot stills—some bad and some good; but although for the last three years I have been fortunate enough to be associated with one of the newest forms of continuous still, I am afraid that to-day I can only say that I have got an open mind. From the works costs points of view, the continuous tar plant does not come anywhere near the other.

When I tell you that with a good up-to-date pot-still installation—one that I have actually seen and the best thing I ever heard of—one can get 120 tons per day, with one man in attendance, you will realize what I mean. Information of this sort is very difficult to get hold of; and I am very pleased that the Chemical Engineering and Wilton's Patent Furnace Company have given a figure. They say 40 tons; but I have seen more than 40 tons done with these Wilton stills. My own actual experience with pot stills has been that, even with a very bad tar, you can get 70 tons. If you put a 30-ton continuous plant down, you will find to-day, especially if it has to be solid-fuel fired, that you will have to have one man to work one still. To a great extent this may be due to the fact that pot stills were started when men used to work, and continuous stills have started since they began to ease-off; and to-day you cannot get a man on a new plant to do what the old-fashioned men did, and, perforce, have to do now, because they used to do it. That is an important point with all these new plants. You can see that with a 30-ton plant you will get 30 tons, against the best practice of 120 tons. This, of course, is rather a serious matter. I am not in a position to-day to give any costs, because they vary in every case. They vary considerably with the quality of the tar, and also with the districts, as regards wages and conditions of working. Another outstanding feature of continuous stills is that for the most part they are easily repaired, although they are probably rather expensive. If you get a pot still with the top or bottom giving way, it is a long job to get it repaired. It means one or two or more months sometimes, even if you keep a spare top to put in. With the Hird distilling plant, which is well described in this paper, the repairs are expensive. They are more expensive than pot stills, but you can get them done in a few days.

With regard to fuel consumption, this, again, is an important point. It seems obvious to me that if you put the fire right under the tar that is going to be distilled, you will get the full value of the heat—you will get the radiant heat. There are stills in the North of England, at Middlesbrough, where the waste heat from the fire of the primary still is carried up through a flue round the heater. I do not think you can possibly get any more heat out of that fuel than you are getting, with the exception of the heat that is coming away in the pitch; and we do not seem to find that that is very much. We can trap this with a continuous plant; but we do not find it is of great importance. Then, again, with continuous stills it is difficult to get information about them unless people want to sell you one; but you will find that you have to use an expensive fuel to get your results. I know that for small places—particularly coke-ovens, where, apparently, gas does not cost anything—these Hird plants are an unqualified success; but when you come to fire them with solid fuels, then the troubles begin. I know they are very serious troubles, because I have had to deal with them for several years, although, I am pleased to say, they can be made to run successfully. We hear of gas-works that are distilling tar by heating with coal gas. This is a bad thing to do to-day, when prices are as high as they are; but it is always a bad thing to do. If you can distil tar with breeze, which is a cheap fuel, then I think you ought to do it. Gas is very convenient and very nice; but it can never be as cheap as breeze. Even if you get gas for nothing, you ought to be selling it. Gas is too important to burn under tar distillers. I do not think you can gasify breeze successfully to make producer gas. I am not an expert at that. I have been told, however, that it is difficult to gasify breeze to make a good producer gas; but you can burn breeze under tar distillers. It is done every day; and it gives a cheap distillation of tar that coal gas, of course, cannot do.

I do not know how far the question of the type of plant to choose affects another vexed question, and that is, to what extent it is desirable a gas-works should distil their own tar. Some of these plants are better for a small installation. The continuous plant to-day in a large installation cannot touch the pot still financially; but probably it might in a small works, because if you have some tar to distil, provided one man can distil it, in a continuous still, you cannot split the man up very well, and you must have a man to distil the tar. So that to that extent it should be considered how far it is desirable for medium or small gas-works to put up these plants and distil their own tar. You might have a sale for dehydrated tar; but it is not always going to take all your tar. We know that; and in the end you will probably find it is not a nice thing to continue a lot of small works all distilling their stuff and competing to sell it. One must come to think that it would be very much more efficiently distilled and marketed, which is more important, by one large centre. That has really nothing to do with the paper, except in so far as it might lead one to select a certain type of plant.

Mr. J. P. LEATHER (Burnley): Having just been told by someone with some experience of tar distilling that it is wrong to use gas, I thought I had better get up and say that I am doing it. Some of the things that have been mentioned have been very interesting, especially as they come from someone with experience of the different types of tar-distilling plant; but they do not altogether affect us if we have decided—say, in a small works—to distil our own tar. For instance, we are told that one man can do 120 tons of tar per day; but we have not got 120 tons of tar a day to dispose of, and it does not concern us very much. If we have to have a tar plant, one man can certainly well look after it in a small works—even a continuous plant, if it is properly designed for the purpose. We have the Hird type of plant, and it seems to me to be an easy plant to work. It takes up very little room, and is quite a neat sort of thing. The plant can be well watched. The tar passing from one still to another is watched regularly by pyrometer; and the man can put the temperature down, and, of course, can maintain it by regulating the gas supply, if you are heating by gas, at the determined temperature which you instruct the man to keep. But I should like to say that, with regard to economy of heat, I certainly think the plant shown in the paper, and as supplied to us, is not economical of heat. We found very soon that the temperature of the waste gases passing away was very high, and that something ought to be done, especially as we were using expensive fuel—in our town gas—to minimize that. We therefore put in extra flues round the stills to take the waste heat, we increased the yield of the plant in number of tons of tar per day, and we increased its economy very considerably from what it was when we first started. I must say that the amount of gas used when we first got the plant was more than we were given to understand beforehand would be the case. We were told that with coke-oven gas, of low calorific power, so much gas would be required. I think it was 1300 c.ft. per ton; but we used more than that of higher calorific value gas. Since then, however, we have reduced our consumption considerably. We have done this partly by taking the flues round the stills, and also by obtaining more perfect combustion in the heating tubes. We have put in clay baffles in the heating tubes which get red hot and ensure perfect combustion in the heating tubes. Otherwise you are liable to get gas passing out of the heating tubes without complete combustion. Apart from the high temperature of the waste gases, the plant is easy to work, certainly, with gas. If you use breeze in the furnaces, we know well there will be a good deal more work for the men; and under these conditions one man would not work this type of plant. I thought I would give these few remarks on an experience, as I feel that this type of paper is useful, because we have such a ready reference to the various types of plant which are available for us.

The PRESIDENT: I propose now to close this discussion. It is a very difficult matter really, because this is not a paper. It is a presentation to us of a book of reference for use in our own works. It is a most admirable work, and likely to be of the greatest possible use. The remarks we have had put before us this morning also are of the most practical character; and I am sure they will be given heed to, not only by the members of the Institution who are present, but by those gentlemen who have to do with the manufacture of these particular plants. I think it only remains for us now to give a hearty vote of thanks to the Society of British Gas Industries for presenting this paper to us, and to Mr. Fred. J. West for the manner in which he has presented it this morning.

The vote of thanks was given with acclamation.

INSTITUTION GAS RESEARCH FELLOWSHIP—1921.

THE LIBERATION OF NITROGEN FROM COAL AND COKE AS AMMONIA.

By A. C. MONKHOUSE, B.Sc. (Institution Gas Research Fellow), and J. W. COBB, C.B.E., B.Sc. (Livesey Professor).

(With an Additional Note on the Liberation of Sulphur.)

NOTE.—A considerable proportion of the work described below was carried out by Mr. Monkhouse and myself in the year preceding his appointment to the Institution Gas Research Fellowship in October, 1920, but is reported here.—JOHN W. COBB.

The influence of atmosphere upon the products of carbonization forms the main thesis of the William Young Memorial Lecture for 1918; and in no application is the principle more important than in the production of ammonia from coal. A certain amount of ammonia comes away easily by the simple application of heat in an inert atmosphere; but when the evolution has ceased (or even before that time), it is possible to obtain more ammonia if the atmosphere is changed to one which assists the process of making ammonia or preserving it when made.

Our study is specially directed towards the further elucidation of this phenomenon. It has been investigated before, but we have attempted to secure more definite and quantitative results with relation to three gases which may be taken as typical for the purpose—nitrogen as inert (excepting in one special sense), hydrogen and steam as potentially active in different ways. Although at a later stage we hope to investigate the influence of these gases on the production of ammonia from the beginning of carbonization, the investigation which we now describe was more specially directed towards the comparative behaviour of the three gases named in influencing the further yield of ammonia when carbonization at a low temperature (500° C.) had been already effected, and when any differences in their action might be expected to declare themselves unmistakably.

On carbonizing coal, it is found that the percentage of the total nitrogen of the coal obtained as ammonia is 10 to 25 p.ct. The greater portion—40 to 80 p.ct.—is left in the coke; the remainder is found as free nitrogen and cyanogen in the gas, and a little in the tar.

The liberation of ammonia in carbonization processes has been shown to be affected by various factors, such as:

1.—*The Rate of Distillation.*—The slower the rate of distillation, the more nitrogen is usually obtained as ammonia.

2.—*The Nature of the Coal.*—Generally speaking, the older the formation of the coal geologically, the smaller is the proportion of the total nitrogen obtained as ammonia.

3.—*The Temperature of Distillation.*—The higher the temperature of distillation, the less nitrogen is left in the coke. Temperatures above 500° C. are necessary for a good yield of ammonia.

In complete gasification with air and an excess of steam, as in the Mond process, the yield of ammonia is much higher than in carbonization—60 to 70 p.ct.

The nature of the nitrogenous constituent or constituents of coal has not been definitely established; but there is some indication of the presence of amino groups which give ammonia on simple distillation (1). The more stable compounds left in the coke are perhaps complex ring formations with nitrogen existing in the ring—the so-called carbon nitrides (2).

The influence of hydrogen in increasing the yield of ammonia was pointed out by Tervet in 1883 (3). Tervet heated coal in an iron tube at red heat; and when he passed a current of hydrogen over the red-hot coke, a large and steady evolution of ammonia resulted. This did not occur with other gases such as carbon dioxide, methane, and nitrogen, and only to a very slight degree with carbon monoxide. Hard, high-temperature coke did not yield ammonia. He obtained a maximum of 67 lbs. of ammonium sulphate per ton of coal.

Beilby in 1884 (4) repeated Tervet's experiment; and the temperature used in this case was a well-marked blood-red in diffused daylight (we should estimate this to mean 600° to 700° C.). He obtained by distillation for 30 minutes, 27 lbs. of ammonium sulphate, and on passage of hydrogen a further increase of 39·88 lbs., making a total of 66·88 lbs. of ammonium sulphate per ton of coal.

Anderson and Roberts (5) in 1899 found that quickly heated coal kept afterwards at a bright-red heat for five or six hours lost no more nitrogen, thus:

	A P.Ct.		B P.Ct.
Nitrogen in coke after 5 minutes	2·19	..	2·10
,, ,, ,, 6½ hours	2·14	..	2·18

They also found that, on passing hydrogen, ammonia was at once liberated.

Christie in 1908 (2), however, distilled coal to 480° C. with and without a stream of hydrogen, and obtained substantially the same result in each case. He also heated 1 grm. of Shamrock coke for 13¼ hours in a rapid stream of gas containing 55 p.ct. of hydrogen at 670° C., and obtained no diminution in the nitrogen of the coke.

He concluded from this that the nitrogenous compounds in coal were not reduced in amount by hydrogen before or during the coking period, and that the action of hydrogen was not to diminish the fixed nitrogen of the coke, but merely to retard the dissociation of the ammonia formed. He explained differences in the fixed nitrogen of cokes as due to the rates of heating.

One of us investigated the action of various gases on coke in relation to the recovery of ammonia some years ago (6), using a coke which was much softer than a metallurgical coke, having been subjected to a temperature of some 900° C., and found that dry hydrogen did not liberate any large quantity of nitrogen from that coke as ammonia; the only gas to do so being steam, either alone or accompanied by hydrogen or nitrogen.

We have attempted to throw some light on this somewhat conflicting testimony. Our method was to take a particular coal, and to coke it at three definite temperatures—500°, 800°, 1100°—so preparing soft, medium, and hard cokes. The action of hydrogen on these three cokes was then determined at three different temperatures—600°, 800°, and 1000° C. In order to differentiate between any specific action of hydrogen on the nitrogen compounds and the influence of an inactive gas, similar experiments were made using nitrogen instead of hydrogen. Comparison with steam followed.

A Yorkshire bituminous coal (Pope and Pearson's Warren House No. 1) was used in the experiments. Its analysis is given:

Proximate Analysis by the Method of the American Chemical Society.

Moisture (air-dried sample)	5·38
Volatile Matter	33·96
Fixed Carbon	56·00
Ash	4·66
	100·00

Ultimate Analysis.

			Calculated to Dry Ash-Free Coal.
Carbon	73·26	..	81·44
Hydrogen	5·06	..	5·62
Nitrogen	1·67	..	1·86
Oxygen and Sulphur (by difference)	9·97	..	11·08
Ash	4·66	..	—
Moisture.	5·38	..	—
	100·00	..	100·00

PREPARATION OF THE COKES.

A fireclay crucible was used for coking, in the lid of which was drilled a hole to permit of the passage of a thermo-couple and sheath. The coal was weighed into the crucible, and packed round the fireclay sheath. The lid was fixed by fireclay slip, leaving a small hole for the escaping gases.

The crucible was heated in an injector furnace. The temperature was raised until the thermo-couple registered the required temperature, and was then kept constant for three hours. The furnace was shut off, the crucible allowed to cool, and the coke weighed. For our experiments, the coke was ground to pass through a ¼ in. and over a ⅛ in. sieve. The rates of heating during the coking period are shown in the accompanying graph (fig. 1).

Roughly speaking, the 500° C. coke can be taken as resembling the product of low-temperature carbonization, the 800° C. coke average gas-works practice, and the 1100° C. coke bye-product coke-oven practice (hard metallurgical coke); and this may be borne in mind in interpreting the results obtained. The total time of coking in each case was about six hours; and the yields obtained were:

Temperature of Coking. ° C.		Per Cent. Coke.
500	..	70·0
800	..	62·6
1100	..	55·5*

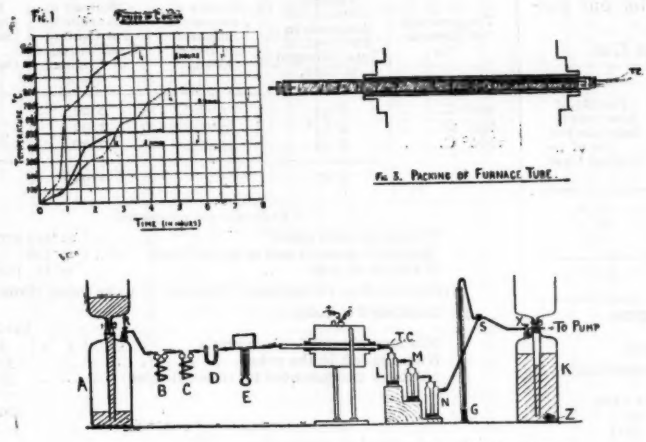
* This yield was undoubtedly low, due to superficial oxidation. The upper layer was removed before preparing the sample.

The analyses of the cokes are given below. The nitrogen content had diminished as the temperature increased.

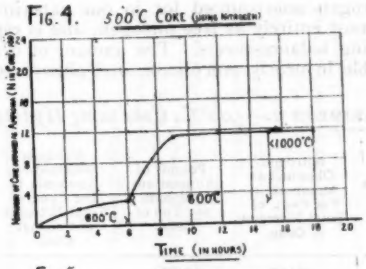
	500° C. Coke.		800° C. Coke.		1100° C. Coke.
Moisture and loss at 105°C.	3·33	..	2·30	..	0·24
Ash	4·53	..	6·22	..	4·87
Carbon	82·28	..	88·16	..	93·05
Hydrogen	3·03	..	0·90	..	0·61
Nitrogen	1·87	..	1·34	..	0·58
Oxygen and sulphur and loss, &c. (by difference)	4·96	..	1·08	..	0·65
	100·00		100·00		100·00

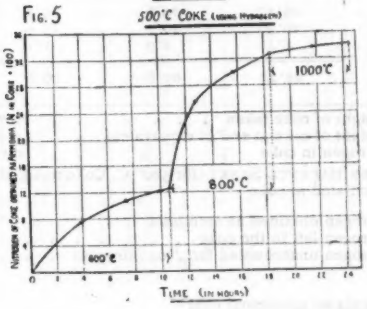
Coke Analyses Calculated Ash-Free and Dry.

	500° C. Coke.		800° C. Coke.		1100° C. Coke.
Carbon	89·30	..	96·38	..	98·06
Hydrogen	3·29	..	0·98	..	0·64
Nitrogen.	2·03	..	1·46	..	0·61
Oxygen and sulphur and loss, &c.	5·38	..	1·18	..	0·69
	100·00	..	100·00	..	100·00



Figs. 1 to 5.





Method of Analysis.

Nitrogen in coal and coke was estimated as follows: 1·0 to 1·5 grams of coke were heated with 1 gram of mercuric oxide and 40 c.c. of concentrated sulphuric acid. After half-an-hour's heating, 10 grams of potassium sulphate were added, the heating continued until no carbon particles were visible, and then for a further two hours. The solution was treated, and ammonia distilled from it, in the usual manner.

This form of Kjeldahl method was used throughout for the determination of nitrogen. The method had been used in all our earlier experiments, and was continued. It is known from the work of Terres (†) and the Gas Investigation Committee (*) that other methods yield rather higher results, and that the Kjeldahl method should always be worked in the same way if the results in a series are to be comparable.

Description of Apparatus. (Figs. 2 and 3.)

The nichrome electric furnace used was examined along its length; and a constant temperature range of 4 in. in the furnace length was established, with a rapid fall of temperature to both ends. The nitrogen or hydrogen was taken from a cylinder and passed over heated copper gauze to remove oxygen, before passing into the graduated gasholder A. The gas then passed through:

1.—A spiral B, containing an alkaline solution of pyrogallic acid to remove the last traces of oxygen.
2.—A spiral C, charged with concentrated sulphuric acid.
3.—A U-tube D, containing calcium chloride, to remove moisture.

A capillary gauge E was used to ensure a steady rate of flow during the course of an experiment.

The silica furnace tube was given a slight slope in the direction of the gas flow; and the coke which was to be treated was packed in the constant temperature range of the tube. The remaining space was filled with fireclay blocks; and the thermocouple sheath was so placed that the tip was in the centre of the mass of coke (fig. 3). Following the reaction tube were washers containing sulphuric acid for the absorption of ammonia, an extra washer for sulphuretted hydrogen, a water pump, and a second measuring gasholder K. After fitting-up and charging with coke, the whole train was evacuated by the water-pump, and then filled with the gas to be used—say, hydrogen.

The heating of the furnace was commenced; and the gas was allowed to expand into the gasholder K. The volume of gas in the gasholder A was measured; and on the desired temperature being reached, the tap R was opened, giving the necessary head. The tap marked Z was opened to give sufficient pull to overcome the seal of the washers, and the flow from Z was regulated by a screw clip. Water was run into the top of the gasholder A at such a rate as to ensure stable conditions of flow.

At the end of an experiment, the tap Z was closed and the tap X to the gasholder; the current being switched off. Thus on cooling, gas was drawn in from the gasholder A. When cold, the washers were disconnected, and the contents examined. The liquid in the first washer L was titrated directly to give an approximate value; then the contents of the second washer M were added, and the whole distilled into standard acid.

A washer N, containing dilute caustic soda, was placed in the circuit, in order to absorb sulphuretted hydrogen. This was done so that the formation of sulphuretted hydrogen might be studied, as far as was found desirable and practicable, at the same time as that of ammonia. The sulphuretted hydrogen was estimated by acidifying with acetic acid and titrating against standard iodine solution. The results so obtained will be reported separately.

In each experiment, the amount of gas passed, its average time of contact with hot coke, the total time of treatment, and the ammonia produced were determined. The average time of contact was some five seconds, of the same order as in carbonization.

In the first part of the work, each of the three cokes prepared as described at 500° C., 800° C., and 1100° C. was subjected to the action of a current of gas at three successive temperatures —600° C., 800° C., and 1000° C. The experiment was repeated several times at each temperature before raising the coke to a higher temperature, according as the evolution of ammonia progressed; but in these first experiments (to save time) the evolution of ammonia at one temperature was not necessarily quite completed before the temperature was raised further. At the end of the treatment with a particular gas, the furnace tube was dismantled, and the coke removed, weighed, and analyzed. On the basis of the results so obtained, a nitrogen balance-sheet was prepared, showing quantitatively what had happened.

Experiments with 500° C. Coke.

This coke can be considered roughly as representative of low-temperature carbonization. On raising the temperature above 500° C., it would undergo further decomposition in any case.

Nitrogen in original coal = 1·67 p.ct., equivalent to 176·3 lbs. of $(NH_4)_2SO_4$ per ton of coal.
Nitrogen in coke = 1·87 p.ct. or 197·5 lbs. of $(NH_4)_2SO_4$ per ton of coke or 138·3 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
Coke = 70·0 p.ct. of original coal by weight.
Average volume of gas passed = 12·5 litres.

The gas collected, excepting in the first period of rapid decomposition on raising the temperature, was not measurably different from that of the gas passed over.

The average rate of flow was 4·0 litres per hour, which corresponds with a time of contact with the hot coke of

6·1 seconds at 600° C.
5·0 ,, ,, 800° C.
and 4·2 ,, ,, 1000° C.

Experiment 1.—500° C. *Coke using Nitrogen Gas.*

Temperature of Furnace ° C.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Coke.	Equivalent Pounds of Ammonium Sulphate Per Ton of Coke.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Original Coal.	Pounds of Ammonium Sulphate Per Ton of Original Coal.
600° C. . .	3·1 } 11·66	6·2	2·5	4·3
800° C. . .	8·56 }	17·0	6·7	11·9
1000° C. . .	0·06	0·1	0·05	0·1
	11·72	23·3	9·25	16·3

Weight of coke taken . . . . . 17·030 grms.
Weight of coke at end of experiment . . . 14·349 ,,
Nitrogen in coke ,, ,, ,, . . 1·34 p.ct.

Nitrogen Balance-Sheet (for 500° C. Coke using nitrogen gas).

1a. Calculated to coke—

	Per Cent.
Nitrogen obtained as ammonia	11·7
Nitrogen left in the coke	60·4
Nitrogen unaccounted for (chiefly as free nitrogen) .	27·9
	100·0

1b. Calculated to original coal—

	Per Cent.
Nitrogen driven off in various forms during coking .	21·6
Nitrogen obtained as ammonia by passage of nitrogen	9·2
Nitrogen left in the coke	47·3
Nitrogen unaccounted for (chiefly as free nitrogen) .	21·9
	100·0

The nitrogen unaccounted for in our experiment would be present almost entirely as free nitrogen, and is reported as such in succeeding balance-sheets. The amount of cyanogen would be negligible in nearly every case, and always so for our purpose.

EXPERIMENT 2.—500° *C. Coke using Hydrogen Gas.*

Temperature of Furnace °C.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Coke.	Pounds of Ammonium Sulphate per Ton of Coke.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Original Coal.	Pounds of Ammonium Sulphate per Ton of Original Coal.
600° C. . .	12·47	24·6	9·8	17·2
800° C. . .	20·30	40·1	15·9	28·1
1000° C. . .	1·47	2·9	1·1	2·0
	34·24	67·6	26·8	47·3

Weight of coke taken . . . . . 17·725 grms.
Weight of coke at end of experiment . . 14·369 ,,
Nitrogen in coke ,, ,, . . 0·65 p.ct.

NITROGEN BALANCE-SHEET (for 500° C. Coke using Hydrogen Gas).

2a. Calculated to coke—

	Per Cent.
Nitrogen obtained as ammonia	34·2
Nitrogen left in the coke	28·2
Nitrogen unaccounted for (free nitrogen) . . .	37·6
	100·0

2b. Calculated to original coal—

	Per Cent.
Nitrogen driven off in various forms during coking.	21·6
Nitrogen obtained as ammonia by passage of hydrogen	26·8
Nitrogen left in the coke	22·1
Nitrogen unaccounted for (free nitrogen). . . .	29·5
	100·0

The results obtained by treating the 500° C. coke with hydrogen instead of nitrogen show a very marked increase in the ammonia yield—34·2 p.ct., as against 11·7 p.ct.—also that, while using hydrogen, the fixed nitrogen in the coke was diminished to 28 p.ct. of that originally present. The corresponding decrease using nitrogen was very much smaller—60 p.ct. of the original nitrogen of the coke being left therein after treatment. From these two results, it seems that the hydrogen with the 500° C. coke exercised a specific action on the nitrogen in the coke with the formation of ammonia in a stable condition, an action which nitrogen did not exert.

From fig. 5 it will be seen that, in the hydrogen experiment, on raising the temperature from 800° to 1000° C., the ammonia recovery decreased, probably owing to the much greater rate of dissociation of ammonia at the higher temperature. Figs. 4 and 5 and the balance-sheets given indicate the full results in both cases.

EXPERIMENTS WITH 800° C. COKE.

This coke may be taken as representative of ordinary gas-works practice.

Nitrogen in original coal = 1·67 p.ct., equivalent to 176·3 lbs. of $(NH_4)_2SO_4$ per ton of coal.
Nitrogen in coke = 1·34 p.ct., equivalent to 141·5 lbs. of $(NH_4)_2SO_4$, per ton of coke, equivalent to 88·6 lbs. of $NH_4)_2SO_4$ per ton of original coal.
Coke = 62·6 p.ct. of original coal.

The average volume of gas passed was 12·5 litres. The gas collected, excepting while raising to 1000° C., was not measurably different from that of the gas passed over. The average rate of flow was 4·9 litres per hour, which corresponds with a time of contact with the hot coke of 4·1 seconds at 800° C.

EXPERIMENT 3.—800° *C. Coke using Nitrogen Gas.*

Temperature of Furnace °C.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Coke.	Pounds of Ammonium Sulphate per Ton of Coke.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Original Coal.	Pounds of Ammonium Sulphate per Ton of Original Coal.
600° C. . .	0·34	0·5	0·17	0·3
800° C. . .	—	—	—	—
1000° C. . .	—	—	—	—
	0·34	0·5	0·17	0·3

Weight of coke taken . . . . . 20·399 grms.
Weight of coke at end of experiment . . 18·818 ,,
Nitrogen in coke ,, ,, . . 1·02 p.ct.

NITROGEN BALANCE-SHEET (for 800° C. Coke using Nitrogen Gas).

3a. Calculated to coke—

	Per Cent.
Nitrogen obtained as ammonia	0·3
Nitrogen left in the coke	70·2
Nitrogen unaccounted for (free nitrogen). . . .	29·5
	100·0

3b. Calculated to original coal—

	Per Cent.
Nitrogen driven off in various forms during coking.	49·7
Nitrogen obtained as ammonia by passage of nitrogen	0·2
Nitrogen left in the coke.	35·3
Nitrogen unaccounted for (free nitrogen). . . .	14·8
	100·0

EXPERIMENT 4.—800° *C. Coke using Hydrogen Gas.*

Temperature of Furnace °C.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Coke.	Pounds of Ammonium Sulphate per Ton of Coke.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Original Coal.	Pounds of Ammonium Sulphate per Ton of Original Coal.
600° C. . .	0·44	0·6	0·22	0·4
800° C. . .	2·64*	3·7	1·32	2·3
1000° C. . .	0·79	1·1	0·40	0·7
	3·87	5·4	1·94	3·4

* Evolution not completed.

Weight of coke taken . . . . . 21·345 grms.
Weight of coke at end of experiment . . 20·100 ,,
Nitrogen in coke ,, ,, . . 0·84 p.ct.

NITROGEN BALANCE-SHEET (for 800° C. Coke using Hydrogen).

4a. Calculated to coke—

	Per Cent.
Nitrogen obtained as ammonia	3·9*
Nitrogen left in the coke	59·0
Nitrogen unaccounted for (free nitrogen) . . .	37·1
	100·0

* Evolution not completed.

4b. Calculated to original coal—

	Per Cent.
Nitrogen driven off in various forms during coking.	49·7
Nitrogen obtained as ammonia by passage of hydrogen	2·0
Nitrogen left in the coke	29·7
Nitrogen unaccounted for (free nitrogen). . . .	18·6
	100·0

Treatment of the 800° C. coke with nitrogen gas at 600°, 800°, and 1000°, therefore, removes 30 p.ct. of the nitrogen in the coke; but if any ammonia was formed, practically the whole of it was decomposed, since only 0·3 p.ct. was recovered. Even this small amount of ammonia evolved at 600° C. was not obtained in a similar experiment several months later, and was probably present in the pores of the coke. The hydrogen gas removed 41 p.ct. of the nitrogen of the coke. Only 3·9 p.ct. was obtained as ammonia; but evolution at 800° had not ceased when the temperature was raised to 1000°, and later experiments demonstrated that a continuation of heating at 800° in hydrogen would have given much more ammonia. The same reaction may have been responsible for the formation of ammonia in some quantity at 1000° C. in this experiment; but if so, it was rapidly dissociated. The results are plotted in fig. 6. If the nitrogen balance-sheets for heating 500° coke (2b) and 800° C. coke (4b) in hydrogen be compared, it will be seen that there was rather more nitrogen left in the 800° C. coke (calculated back to the original coal) after treatment with hydrogen than in the 500° C. coke. With nitrogen (1b and 3b) the reverse was observed—*i.e.*, a larger percentage of the total nitrogen was left in the 500° C. coke after treatment than in the 800° C. coke.

The simplest explanation of this result is that the removal of nitrogen between 500° and 800° C. was greatest with hydrogen, least with nitrogen, and intermediate with crucible carbonization, and that nitrogen left in the coke is always more difficult to remove when the temperature is higher—*i.e.*, that the coke-nitrogen compounds existing at the higher temperature are less easily decomposed.

EXPERIMENTS MADE WITH 1100° C. COKE.

This coke is roughly representative of hard metallurgical coke.

Nitrogen in coke = 0·58 p.ct., equivalent to 61·2 lbs. of $(NH_4)_2SO_4$ per ton of coke.

EXPERIMENT 5.—1100° *C. Coke using Hydrogen Gas.*

No experiment was made at this stage using nitrogen gas; but hydrogen was tried at 600°, 800°, 1000° C., as before. It gave no ammonia; and after passing hydrogen, the coke showed no diminution in nitrogen content. Therefore, the hydrogen had not attacked the 1100° C. coke up to the temperature of 1000° C. It is a safe presumption that nitrogen would have given the same negative result.

The results so far obtained have shown that—

A.—On a soft coke prepared at 500° C., the further action of hydrogen resulted in a considerable attack on the nitrogen present in the coke, and the formation of considerable quantities of ammonia, recoverable because formed under stable conditions.

B.—With the medium 800° C. coke, the attack of hydrogen was less extensive and the amount of ammonia recoverable smaller.

C.—With the hard 1100° C. coke, the hydrogen had no power of attack.

In all cases the rate of recovery of ammonia was more rapid at 800° C. than at the lower temperature 600° C., or the higher temperature 1000° C., though we cannot say, from the experiments so far recorded, that at 1000° C. there had not been a vigorous attack of the nitrogen compounds by hydrogen followed by rapid decomposition of the ammonia formed. The maximum recovery of ammonia, so far obtained, using hydrogen

on the 500° C. coke, was equivalent to 34·2 p.ct. of the nitrogen contained in the coke, or 26·8 p.ct. of the nitrogen in the coal, equivalent to 47·3 lbs. of ammonium sulphate per ton of coal.

Our next experiment was to determine whether the nitrogenous constituent existing in the high temperature coke, though undecomposed by dry hydrogen, could be decomposed by the use of hydrogen and steam together, with the liberation of ammonia. A slight modification in our existing apparatus was made (fig. 7). The gas delivery tube was carried forward into the hot length of the furnace. A flask containing water was immersed in a water bath, the thermometer indicating the temperature of saturation of the gas leaving the flask; and hydrogen was used as a carrier gas for the steam. The weights of water in the flask at the beginning and end of an experiment served as a check against the temperature of saturation in determining the proportions of hydrogen and steam.

This was a preliminary experiment made to confirm previous work, and to indicate to some extent the velocity of the reaction. The results follow:

FIG. 7. SATURATOR

EXPERIMENT 6.—1100° *C. Coke using Steam and Hydrogen.*

The gas collected was in excess of the volume passed, owing to the water-gas reaction.

The percentage of steam in the steam-hydrogen mixture was 65.

The rate of passage of the mixed gas was 13 litres per hour, corresponding with a time of contact of

1·9 seconds at 600° C.
1·5 ,, ,, 800° C.
1·3 ,, ,, 1000° C.

Temperature of Furnace.	Nitrogen Obtained as Ammonia in Per Cent. of Total Nitrogen of Coke.	Ammonium Sulphate per Ton of Coke.
600°	0·20 p.ct.	0·1 lbs.
800°	2·97 ,,	1·8 ,,
1000°*	2·57 ,,	1·6 ,,

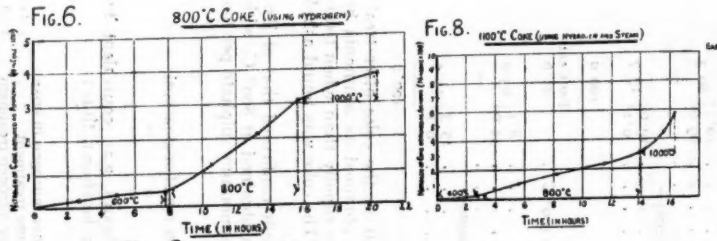
* The experiments were stopped without completing evolution of ammonia.

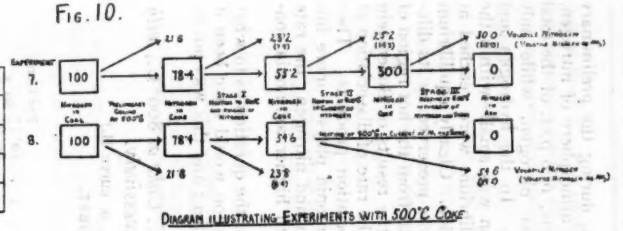
NITROGEN BALANCE-SHEET (1100° C. Coke, using Steam and Hydrogen).

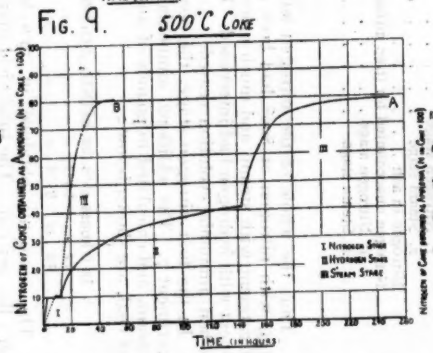
	Per Cent.
6.—Calculated to coke—	
Nitrogen liberated as ammonia	5·7
Nitrogen left in coke	87·9
Nitrogen unaccounted for (free nitrogen) .	6·4
	100·0

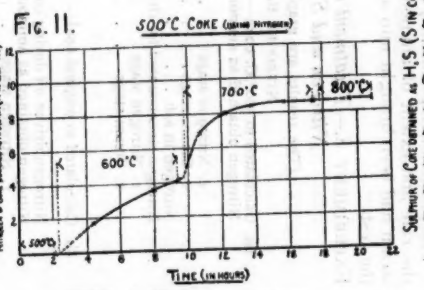
The results plotted in fig. 8 indicate that hydrogen did not attack the hard coke, but that using steam and hydrogen a slow but steady evolution of ammonia occurred. The balance-sheet shows free nitrogen, presumably from decomposition of part of the ammonia formed.

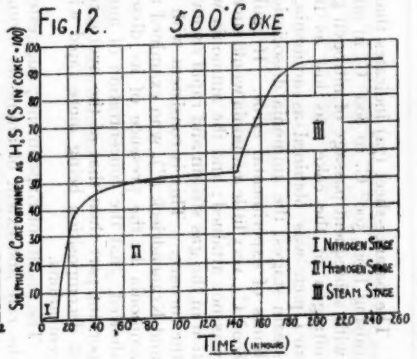
The action of steam on coke with the liberation of ammonia is well-established, and is the basis of the Mond system of gasification [4, 6, 9]. Salmang has made the very interesting assertion that the carbon-nitrogen ratio in the coke remains constant during the period of gasification in steam. This means that decomposition of the nitrogen compound involves the simultaneous or immediately preceding gasification of any carbon which surrounds or accompanies it; or, in other words, that the surrounding carbon must be gasified before the nitrogen compound is laid open for attack. If this statement is true, it is very important as limiting the practicability of using steam for increasing the ammonia yield where coke is one of the desired products; and we propose to investigate its validity.











FIGS. 6 TO 12.

RESULTS OBTAINED BY SUCCESSIVE ACTION OF NITROGEN, HYDROGEN, AND STEAM.

A set of experiments was made next in which the attack of one gaseous reagent was complete, or practically so, before another was allowed to act. In this way, an attempt was made to determine how far the nitrogen of the coke, unaffected by the action of heat and a stream of inert gas, could be removed and recovered as ammonia by the action of hydrogen, and how far the action of steam was useful when hydrogen was no longer effective.

The experiment was carried out as follows: The 500° C. coke was placed in the furnace tube, which was filled with nitrogen gas as previously explained and raised quickly to 800° C. A temperature of 800° C. was chosen because, from our previous work, it appeared to be the optimum temperature for ammonia recovery with hydrogen. Nitrogen was then passed through the tube in a series of treatments until no further ammonia was evolved. A state had thus been attained in which the nitrogenous constituent remaining in the coke was stable at 800° C. in a stream of inert gas. A sample of the coke was then withdrawn for analysis, and a nitrogen balance-sheet drawn up.

The furnace was next raised to 800° C. again, and a current of hydrogen passed over the coke. A series of treatments was made until the ammonia evolved was considered negligibly small. Another coke sample was drawn and analyzed, and another balance-sheet made. As there still remained in the coke at this stage a proportion of nitrogen unattacked by hydrogen, the experiment was continued, using a mixture of nitrogen saturated with steam, until no further ammonia was evolved.

This experiment made at 800° C. on the one sample of coke prepared at 500° C. may be divided for convenience into three stages:

1.—The nitrogen stage.
2.—The hydrogen stage.
3.—The steam stage.

EXPERIMENT 7.—500° *C. Coke at* 800° *C.*

Weight of coke used . . . . . 17·717 grms.
Nitrogen in coke . . . . . 1·87 p.ct.
The results are graphed in fig. 9, Curve A.

1.—*The Nitrogen Stage.*—The volume of gas collected after the first rapid decomposition on raising to 800° was not measurably different from the volume of nitrogen passed over. The average rate of flow was 4·2 litres per hour, which corresponds with a time of contact with the red-hot coke of 4·8 seconds. Four treatments were made, as can be seen from the graph (fig. 9, Curve A, Stage I.). Some ammonia was evolved during the first experiment, a very small amount in the second, and no measurable quantity afterwards.

BALANCE-SHEET.

	Per Cent.
Nitrogen obtained as ammonia	10·1
Nitrogen left in the coke.	70·3
Nitrogen unaccounted for (free nitrogen) . . .	19·6
	100·0

Comparing with the results of Experiment 1, it is seen that treatment at 800° gave little less ammonia than successive treatments at 600° and 800°.

2.—*The Hydrogen Stage.*—A point having been reached at which the continued passage of nitrogen gas gave no further ammonia, the treatment with hydrogen was begun. Considerable quantities of ammonia were obtained. The rate of its production was at first rapid, but fell away, until it became plain that a very slow reaction was continuing. From extrapolation of the curve (fig. 9, Curve A, Stage II.), it would appear that probably something like 45 p.ct. of the nitrogen of the coke would have been obtained as ammonia by continuing this hydrogen treatment indefinitely. At the end of 130 hours, this stage of the experiment was, however, stopped; the rate of ammonia evolution having then become extremely slow.

During this hydrogen stage, 32 p.ct. of the nitrogen of the coke had been gasified, and ammonia equivalent to 31 p.ct. had been obtained; the dissociation under these conditions at 800° C. being, therefore, practically nil.

3.—*The Steam Stage.*—When, as described above, the attack of hydrogen on the coke had become negligible, it was followed by treatment with steam, carried by nitrogen. There was 62·5 p.ct. of steam present in the nitrogen-steam gas stream. The volume of gas collected was greater than the volume of nitrogen passed, owing to the gases formed by the action of steam on the carbon of the coke. The average rate of flow of the mixed gases corresponded with a time of contact of 2·6 seconds.

The passage of steam-nitrogen was continued until no more ammonia was evolved, when, on disconnecting, it was seen that only the ash of the coke remained. This stage occupied eighteen periods of six hours each.

NITROGEN BALANCE-SHEET, FOR EXPERIMENT 7.

(Nitrogen, hydrogen, and steam successively at 800° C. on 500° C. coke)

7a. Calculated to 500° C. coke—

		Per Cent.
Nitrogen obtained as ammonia—		
1. Nitrogen stage	10·1	
2. Hydrogen stage	31·0	79·2
3. Steam stage	38·1	
Nitrogen in ash		—
Nitrogen unaccounted for (free nitrogen)—		
1. Nitrogen stage	19·6	
2. Hydrogen stage	1·0	20·8
3. Steam stage	0·2	
		100·0

7b. Calculated to original coal—

		Per Cent.
Nitrogen driven off during coking to 500° C.		21·6
Nitrogen obtained as ammonia—		
1. Nitrogen stage	7·9	
2. Hydrogen stage	24·3	62·1
3. Steam stage	29·9	
Nitrogen in ash		—
Nitrogen unaccounted for (free nitrogen)—		
1. Nitrogen stage	15·35	
2. Hydrogen stage	0·81	6·3
3. Steam stage	0·15	
		100·0

This result indicated clearly that large quantities of ammonia could be obtained at 800° C. by the use of hydrogen when heating in nitrogen had ceased to yield any ammonia, and that a further large quantity could be obtained with steam when hydrogen had become practically ineffective. Also that, during the heating in hydrogen and steam, the nitrogen came from the coke almost exclusively as ammonia which was not appreciably dissociated, but recovered.

By the use of hydrogen, additional ammonia was obtained in the quantities shown below, after heating for periods used in carbonization and bye-product practice.

After 6 hours, ammonia equivalent to 10·9 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
After 12 hours, ammonia equivalent to 16·9 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
After 24 hours, ammonia equivalent to 23·2 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
After 48 hours, ammonia equivalent to 31·5 lbs. of $(NH_4)_2SO_4$ per ton of original coal.

(The additional ammonia, after 130 hours at 800° C. in the atmosphere of hydrogen, was equivalent to 42·8 lbs. sulphate.)

The ammonia yields from the nitrogen remaining in the coke by the use of steam are similarly indicated.

After 6 hours, ammonia equivalent to 15·6 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
After 12 hours, ammonia equivalent to 26·8 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
After 24 hours, ammonia equivalent to 41·0 lbs. of $(NH_4)_2SO_4$ per ton of original coal.
After 48 hours, ammonia equivalent to 48·9 lbs. of $(NH_4)_2SO_4$ per ton of original coal.

(The additional ammonia after 107 hours at 800° C., using steam, was equivalent to 52·7 lbs. of sulphate.)

Summarizing:

1. Nitrogen stage	13·9 lbs. per ton.	
2. Hydrogen stage	42·8 ,, ,,	
3. Steam stage	52·7 ,, ,,	
Total sulphate	109·4 ,, ,,	
Additional sulphate from hydrogen and steam	95·5 ,, ,,	

Per cent. nitrogen in coke:	
Before treatment	1·87
After nitrogen treatment	1·52
After hydrogen ,,	0·95
After steam ,,	*Nil.*

The balance-sheet (7a) indicates that, during the preliminary raising from 500° C. to 800° C. in an atmosphere of nitrogen, with subsequent passage of nitrogen gas, 19·6 p.ct. of the total nitrogen of the coke was lost as free nitrogen, while only 10·1 p.ct. was obtained as ammonia. In the hydrogen and steam stages, the ammonia dissociation was small—within the limits of experimental error. If equilibrium were reached at 800° C., very little ammonia would survive. Clearly equilibrium was not attained; and the ammonia was preserved by its dilution in the gas stream and rapid removal from the hot region of the furnace. This is consistent with the results of Bodenstein and Kranendrieck (10), who examined the rate of dissociation of ammonia in the presence of its dissociation products. They showed that the concentration of ammonia plays a more important part than that of the hydrogen and nitrogen; the rate of decomposition being more rapid with higher ammonia concentrations.

The results of Experiment 7 suggested the question as to what the rate and extent of ammonia formation would have been if steam had been brought into action earlier; and this was put to the test.

EXPERIMENT 8.—*Treatment of 500° C. Coke at 800° C., with Nitrogen and Steam successively.*

(The results are graphed in fig. 9, curve B.)

NITROGEN BALANCE-SHEET.

8a. Calculated to 500° C. coke—

		Per Cent.
Nitrogen obtained as ammonia—		
1. Nitrogen stage	10·7	
2. Steam stage	69·6	80·3
Nitrogen in ash		—
Nitrogen unaccounted for (free nitrogen)—		
1. Nitrogen stage	19·6	
2. Steam stage	0·1	19·7
		100·0

8b. Calculated to original coal—

		Per Cent.
Nitrogen driven off during coking to 500° C.		21·6
Nitrogen obtained as ammonia—		
1. Nitrogen stage	8·4	
2. Steam stage	54·6	63·0
Nitrogen in ash		—
Nitrogen unaccounted for (free nitrogen)—		
1. Nitrogen stage	15·3	
2. Steam stage	0·1	15·4
		100 0

Thus the whole of the nitrogen left in the coke after treating with nitrogen at 800° had been obtained as ammonia by treatment with steam, and much more rapidly than when treatment with hydrogen had intervened. The coke was found ashed when ammonia evolution ceased.

In the first nitrogen stage, the result confirmed that of Experiment 7. The additional ammonia obtained at 800° C. with steam, and calculated to pounds of ammonium sulphate per ton of coal, are shown below:

In 6 hours 40·8 lbs. of $(NH_4)_2SO_4$ per ton of original coal
12 ,, 69·2 ,, ,, ,, ,, ,,
24 ,, 91·2 ,, ,, ,, ,, ,,

The ammonia obtained in 39·6 hours was equivalent to 96·3 lbs. per ton. The total yield may be shown thus:

	Sulphate Per Ton.	
1. Nitrogen stage	14·8 lbs.	Per cent. nitrogen in coke:
3. Steam stage	96·3 ,,	Before treatment 1·87
		After nitrogen treatment 1·50
Total sulphate	111·1 ,,	After steam ,, *Nil*

A diagrammatical representation of Experiments 7 and 8 is given in fig 10, tracing the nitrogen of the coal through the various stages. In the first stages of both Experiments 7 and 8—*i.e.*, in the raising of the 500° C. coke to a temperature of 800° C. in an atmosphere of nitrogen with subsequent passage of nitrogen gas—of the 30 p.ct. of the nitrogen of the coke gasified only 10 p.ct. had been obtained as ammonia. Our next task was to determine whether any more ammonia would be obtained by raising the coke to 800° C. in stages, so tending to minimize dissociation of ammonia liberated.

The 500° C. coke was raised in a current of nitrogen to 500° C., maintained there, and ammonia tests made. The temperature was then raised to 600° C., and similar determinations made at this temperature. The number and duration of these heatings are indicated in fig. 11. The coke was next raised to 700° C., and then 800° C.; a similar procedure being employed. A sample of coke was withdrawn at the end of the experiment, analyzed, and the nitrogen balance-sheet constructed. The results obtained are graphed in fig. 11. In this experiment, a current of nitrogen gas was passed during the whole time. The dotted portions of the curve were obtained by extrapolation, and indicate the passage from one temperature to another.

The results (fig. 11) indicate that there was a considerable evolution of ammonia at 600° C. At 700° C., the quantity of ammonia obtained in the first period of one hour was greater than at 600° C.; but the rate of ammonia recovery fell away much more rapidly. No appreciable quantity of ammonia was obtained at 800° C. The results indicated that, in this heating in stages from 500° C. to 800° C., as compared with direct heat-

ing at 800° C., the nitrogen obtained as ammonia and that as free nitrogen were both rather less; but the ratio of ammonia to free nitrogen was rather greater, being 0·60, as against 0·51.

EXPERIMENT 9.—*500° C. Coke in a Current of Nitrogen Gas at 500°, 600°, 700° and 800° C.*

NITROGEN BALANCE-SHEET.

9a. Calculated to 500° C. coke.

Nitrogen obtained as ammonia—

	Per Cent.	
1. 500° C.	*Nil*	8·7
2. 600° C.	4·2	
3. 700° C.	4·4	
4. 800° C.	0·1	
Nitrogen left in the coke		76·7
Nitrogen unaccounted for (free nitrogen)		14·6
		100·0

9b. Calculated to original coal—

	Per Cent.
Nitrogen driven off in various forms during coking.	21·6
Nitrogen obtained as ammonia	6·8
Nitrogen left in coke	60·1
Nitrogen unaccounted for (free nitrogen)	11·5
	100·0

It would appear that, by heating in nitrogen to 800° C. at once, rather more ammonia was obtained, and much more quickly; but a little more was dissociated, because it came off in greater concentration.

The slow heating by stages to 800° C. showed that the ammonia obtainable by heating in nitrogen was all secured at or below 700° C., if sufficient time were given; but that the loss of ammonia by dissociation was not eliminated, or greatly affected, by this gentle treatment, being equivalent to two-thirds of the nitrogen expelled from the coke. Confirmation of this result, important to practice, was forthcoming from another trial made under similar conditions. In this experiment, on continuing the nitrogen treatment to 900° C., a further 4·7 p.ct. of the nitrogen of the coke was expelled, but only 0·1 p.ct. was obtained as ammonia. Thus, with slow heating in an inert atmosphere, this coal yielded no appreciable quantity of ammonia above 700° C., though it continued to lose nitrogen.

In order to facilitate comparisons, the numerical results obtained have been collected in Tables I. and II.; but reservations are necessary in some cases, as has been explained.

LIBERATION OF SULPHUR FROM COKE AS SULPHURETTED HYDROGEN.

As was mentioned earlier in the description of apparatus, a washer was placed in the train containing caustic soda, for the absorption of sulphuretted hydrogen. In each experiment run for ammonia, parallel determinations of sulphuretted hydrogen were made. These will be reported later, and considered in more detail; but a curve (fig. 12) is introduced to show the results obtained by the treatment of the 500° C. coke with nitrogen, hydrogen, and steam successively at 800° C. It will be seen that there is a parallelism between the results obtained with sulphur and those with nitrogen. When it had become impossible to liberate any more sulphur from the coke as sulphuretted hydrogen by passing nitrogen, a considerable quantity of the sulphur left in the coke was obtained as sulphuretted hydrogen by heating in a stream of hydrogen. When the reaction with hydrogen had become very slow, further considerable quantities of sulphuretted hydrogen were obtained by treatment with

TABLE I.—*Percentage Yields Calculated on the Nitrogen of the Cokes.*

—	Experiment 1. 500° C. Coke using Nitrogen at 600°, 800°, 1000° C.	Experiment 2. 500° C. Coke using Hydrogen at 600°, 800°, 1000° C.	Experiment 3. 800° C. Coke using Nitrogen at 600°, 800°, 1000° C.	Experiment 4. 800° C. Coke using Hydrogen at 600°, 800°, 1000° C.	Experiment 5. 1100° C. Coke using Hydrogen at 600°, 800°, 1000° C.	Experiment 6. 1100° C. Coke using Hydrogen and Steam at 600°, 800°, 1000° C.
Nitrogen as ammonia	11·7	34·2	0·3	3·9	*Nil*	5·7
Nitrogen left in coke	60·4	28·2	70·2	59·0	100·0	87·9
Nitrogen unaccounted for (free nitrogen)	27·9	37·6	29·5	37·1	*Nil*	6·4
	100·0	100·0	100·0	100·0	100·0	100·0

—	Experiment 7. 500° C. Coke using Nitrogen at 800° C.	Experiment 7. 500° C. Coke using Nitrogen and Hydrogen at 800° C. successively.	Experiment 7. 500° C. Coke using Nitrogen, Hydrogen, and Steam successively at 800° C.	Experiment 8. 500° C. Coke using Nitrogen at 800° C.	Experiment 8. 500° C. Coke using Nitrogen and Steam successively at 800° C.	Experiment 9. 500° C Coke raised to 800° C. in Stages in Nitrogen.
Nitrogen as ammonia	10·1	41·1	79·2	10·7	80·3	8·7
Nitrogen left in coke	70·3	38·3	*Nil*	69·7	*Nil*	76·7
Nitrogen unaccounted for (free nitrogen)	19·6	20·6	20·8	19·6	19·7	14·6
	100·0	100·0	100·0	100·0	100·0	100·0

TABLE II.—*Percentage Yields Calculated on the Nitrogen of the Coal.*

—	Experiment 1. 500° C. Coke using Nitrogen at 600°, 800°, 1000° C.	Experiment 2. 500° C. Coke using Hydrogen at 600°, 800°, 1000° C.	Experiment 3. 800° C. Coke using Nitrogen at 600°, 800°, 1000° C.	Experiment 4. 800° C. Coke using Hydrogen at 600°, 800°, 1000° C.
Nitrogen driven off during coking	21·6	21·6	49·7	49·7
Nitrogen obtained as ammonia in experiment	9·2	26·8	0·2	2·0
Nitrogen left in the coke	47·3	22·1	35·3	29·7
Nitrogen unaccounted for (free nitrogen)	21·9	29·5	14·8	18·6
	100·0	100·0	100·0	100·0

—	Experiment 7. 500° C. Coke using Nitrogen at 800° C.	Experiment 7. 500° C. Coke using Nitrogen and Hydrogen successively at 800° C.	Experiment 7. 500° C. Coke using Nitrogen, Hydrogen, and Steam successively at 800° C.	Experiment 8. 500° C. Coke using Nitrogen at 800° C.	Experiment 8. 500° C. Coke using Nitrogen and Steam successively at 800° C.	Experiment 9. 500° C. Coke raised to 800° C. in Stages in Nitrogen.
Nitrogen driven off during coking	21·6	21·6	21·6	21·6	21·6	21·6
Nitrogen obtained as ammonia in experiment	7·9	32·2	62·1	8·4	63·0	6·8
Nitrogen left in the coke	55·1	30·0	*Nil*	54·7	*Nil*	60·1
Nitrogen unaccounted for (free nitrogen)	15·4	16·2	16·3	15·3	15·4	11·5
	100·0	100·0	100·0	100·0	100·0	100·0

steam. By this successive treatment with nitrogen, hydrogen, and steam, 93 p.ct. of the total sulphur in the coke was obtained as sulphuretted hydrogen.

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(10) BODENSTEIN *and* KRANEDIECK, "Nernst Festschrift" (1912), p. 99. Abs. "Journ. Chem. Soc." (1912), *102*, p. 1155.

DISCUSSION.

The PRESIDENT: I beg to move the adoption of the report. I am sure you will agree with me that we owe a very considerable debt of thanks to Dr. Monkhouse and Prof. Cobb for the work the substance of which has just been communicated to us. It certainly seems a wrong thing that in the ordinary course of carbonization only 10 to 25 p.ct. of the nitrogen in the coal should be realized. We have already found, in working with vertical retorts, what evidently is the effect of the steam there—*i.e.*, as a rule there is a very considerable increase in the ammonia we get per ton of coal. It does not matter what the immediate market for ammonia is. Our business is to get as much out of a ton of coal as we can, and leave the markets and other matters of that sort to settle themselves. Our business as engineers is to get the greatest production out of the ton of coal; and it is by research work of this description that we get the information we can ourselves apply to practical use. There can be little doubt that in future our methods of gas manufacture will alter in the direction of using more of our coke, and necessarily, the production of more hydrogen and the use of steam in the manufacture of gas. It is how best to apply these lessons, one of which we have learned to-day, in increasing our products that we must set our wits to work. I shall be glad to have remarks from any gentlemen with regard to the paper.

Dr. R. LESSING (London): May I ask one question with regard to the composition of the ash in the coal used for this particular research? I drew attention to the catalytic effect of some of the inorganic constituents of coal carbonization and combustion in the William Young Memorial Lecture in 1914; and I am firmly convinced—although the experimental proof has not yet been forthcoming—that the kind of ash in the coal will influence both the course of carbonization, and in this particular case the course of the evolution of ammonia or sulphuretted hydrogen, as the case may be. It would therefore be very interesting, having all this very minute detail of these experiments, if it could be added to by the addition of a complete analysis of the ash. The question of the form of the ammonia compounds has been raised, and I understand that work is in hand. It would also be interesting to survey, in doing so, the influence of the ash constituents on the actual compounds which are present in the coke when it is finished. There is no doubt that some such compounds as silicides or carbides must have an influence, if they are not responsible for the various degrees of coke that are obtained at different temperatures. I throw it out as a suggestion, that possibly in the case of the hard coke obtained at 1100° C. some such compounds are formed which prevent the action of the hydrogen or steam on the nitrogenous compounds, the amino compounds, or whatever they are, by some combination between the silica or alumina of the ash; that some of the carbon would close up the pores or molecular free spaces. I should like to congratulate the authors on their very valuable work in this full investigation.

Mr. W. W. TOWNSEND (Colchester): I should like to ask a question which I think is of some importance, but I do not know whether it is possible to answer it accurately. It is quite evident that in making a laboratory experiment of this nature, the time in which the reaction takes place is of very small importance; but in applying it to working on a practical scale, it is of great importance to know whether it would be possible to increase the yield of ammonia very considerably in any feasible time of operation. I notice the curve is made very much sharper in fig. 9 by the use of steam, straight-away after the first part of the distillation. That is a very interesting fact; and it has a very important practical bearing on the subject, because if you look at the other curve, it is quite apparent that it would not be possible to expose coke at a certain temperature to the reaction in order to gain this extra yield of ammonia, because there simply would not be time enough to do it. I should therefore like to ask the authors if they have come to any conclusion as to the time required on an ordinary working scale for carrying out this reaction. Of course, on a laboratory scale even the sharpest curve shows that the coke, I take it, was exposed for 50 hours to a stream of gas. That is the chief point I have to make. With regard to the commercial aspect of the problem, it has been pointed out that it hardly pays at the present time to produce ammonia. But I should like to draw attention to the fact that it is obvious, when you come to think of it, that if we could even double the yield of ammonia, much less obtain the whole of the nitrogen in the coal in the form of ammonia, we should have what we have long been looking for—viz., a new method of liquid purification. We should have as much ammonia as would, in our own case, neutralize the acid gases. Unfortunately for us, however, in obtaining this extra yield of ammonia, we also obtain a very much higher yield of sulphuretted hydrogen. I should like to know whether any calculations have been made, of purely theoretical interest, to show whether the one is a complete offset to the other, or whether it would be possible, by any means of working which can be devised, to obtain the large increase in the yield of ammonia without at the same time getting a great increase in the sulphuretted hydrogen, which would be a very difficult problem to deal with.

The PRESIDENT: I will now call on Prof. Cobb to reply to the points that have been raised.

Prof. COBB: I shall be very brief, and probably say something complementary in writing. In the first place, I thank you for your kind general remarks respecting the paper. I might point out that the 10 p.ct. referred to as recoverable by heating in nitrogen, was a supplementary 10 p.ct., commencing with a soft coke which had been prepared at 500° C.; it did not represent the amount obtained at the beginning with raw coal. That is but a detail which will be seen on any careful detailed perusal of the paper. Dr. Lessing's point is, I think, quite a good one, and I think we ought to add the composition of the ash of the coal. We will do so when the paper comes up for final reproduction in the "Transactions." I certainly think it should be added. As to the theoretical aspect of it, the formation of compounds in the coke during carbonization—this is also a subject on which we hope to put out a further speculation, at any rate, at a later stage. But theoretical speculation has deliberately been excluded from the present paper. As to Mr. Townsend's remarks. As he says, the time factor is of importance; and you will notice, on looking at the paper, that in the first place the time of contact of the gases with red-hot coke in these experiments, as that of others of a similar kind which we have published, has been calculated, and is given. You will find the time of contact is given which allows the conditions to be compared in this respect with works conditions. Apart from that, it is quite true that some of these reactions were carried over periods beyond those associated with normal works practice—50 hours, 100 hours, and so on. That was because we really did want to see whether the hydrogen action could be carried to completion, and so we followed it out further than could possibly be done in works practice. What we established in that way was that the hydrogen did, for all practical purposes, certainly come to a stop after a certain amount of ammonia had been obtained, and that any period which could be contemplated in works practice could give no more ammonia. It will be seen that an attempt has been made to show what kind of results would have been obtained if the periods had been those of ordinary carbonization and bye-product practice. It says "After six hours, ammonia equivalent to 10·9 lbs. of ammonium sulphate per ton of original coal;" "after twelve hours, ammonia equivalent to 16·9 lbs. of ammonium sulphate per ton of original coal"—that represents another works period; and then we give 24 hours and 48 hours, so that we cover the longest period of bye-product coke-oven practice. And then again, we show what happened in the same way, not only with hydrogen, but with steam. The results are all given after 6, 12, 24, and 48 hours. That, I think, is the kind of information which Mr. Townsend suggested as desirable. Then, as to the recovery of sulphur along with ammonia. It is quite true that under the conditions where we obtain more ammonia, more sulphuretted hydrogen is also obtained. Possibly I do not regard that with any degree of apprehension, because I believe the time will come (if it has not already come) when the sulphur in the coal, contained as sulphuretted hydrogen in the gas, would be used as the source of the ammonium sulphate. For that reason, one would not have to regret the production of more sulphuretted hydrogen as the amount of ammonia is increased.

The PRESIDENT: We have had an ample reply, for which we will thank Prof. Cobb. It considerably adds to the value of the paper. I now propose the adoption of the report.

Mr. SAMUEL GLOVER: I have very great pleasure in seconding.

The report was adopted.

PUBLIC WORKS CONGRESS.

Conference Arranged by the Institution of Gas Engineers.

The preliminary programme has been issued of the Public Works, Roads, and Transport Congress, which is to be opened in London on Nov. 18, and continued until the 25th. The Organizing Committee includes representatives of the County Councils Association, the Association of Municipal Corporations, the Urban District Councils Association, the Rural District Councils Association, the British Water-Works Association, the Incorporated Municipal Electrical Association, the Institution of Municipal and County Engineers, the County Surveyors' Society, and the Institute of Cleansing Superintendents.

One branch only of the public services is the subject of a day's conference. Thus, on the first day, the conference is organized by the Institution of Gas Engineers, with Mr. Thomas Hardie, Deputy Chief Engineer of the Gas Light and Coke Company, as Chairman. Papers are to be read by Captain de Normanville, on the "Utility of Benzole;" by Dr. Thomas, on "Public Lighting by Gas;" and by Mr. W. G. Adam, on the "Uses of Tar and other Materials for Road Surfacing."

Water and other subjects will be discussed on different days.

Brigadier-General Sir Henry P. Maybury, K.C.M.G., C.B., is Chairman of the Organizing Committee, and Sir Lawrence Weaver (of the Board of Agriculture), Vice-Chairman.

Simultaneously, and in connection with the congress, there will be a Public Works, Roads, and Transport Exhibition at the Royal Agricultural Hall, Islington, which promises to be of an interesting character.

NATIONAL ASSOCIATION OF TECHNICAL GAS OFFICIALS.

Second Annual General Meeting.

The Second Annual General Meeting of the National Association of Technical Gas Officials was held last Wednesday afternoon at the Central Hall, Westminster—under the chairmanship of Mr. R. G. SHADBOLT, who explained that the meeting had been deferred owing to the postponement in May of the annual meeting of the Institution of Gas Engineers.

The GENERAL SECRETARY (Mr. F. Herbert Stevenson) read the minutes of the last general meeting.

Mr. R. S. RAMSDEN (Leamington) proposed their adoption; and it was agreed to.

There were then presented the annual report and statement of accounts. The report, which was for the year ended May last, included the following:

At the annual general meeting of the Association in June, 1920, the members passed the draft rules tentatively, subject to revision, and confirmed the appointment of the temporary officers, with a view to their continuing the organization of the Association.

The year has, therefore, been largely one of organization; and good progress has been made therewith. Many districts are completely organized with Committees and Honorary Secretaries, and have appointed properly accredited representatives to the General Council. In some districts there is still difficulty, however, in obtaining an Honorary Secretary to take up the work.

A meeting of the General Council was held in Birmingham on Jan. 18, 1921, together with further representatives from the District Sections, to discuss the progress of the Association and to instruct the officers upon the course to be adopted in furtherance of the objects of the Association. The opportunity was taken of putting the Executive Committee upon a constitutional basis, and strengthening it with new members. This Committee has met monthly since then, and much progress has been made.

The rules have been completely revised; and the alterations are recommended by the General Council for acceptance by the members at the annual general meeting.

Notwitstanding the comparatively unorganized state of the Association during the year, it has been asked by many members for assistance, and has been able to render practical service, producing tangible results.

The financial position shows that, without the entrance fees, which were paid by all members last year, the Association's activities will be very seriously hampered by lack of funds, unless a greatly increased membership is obtained. All members are, therefore, earnestly entreated to use their personal influence among their colleagues on the Association's behalf.

The CHAIRMAN, in proposing the adoption of the report and accounts, said that the latter showed there was a balance at the bank and cash in the Secretary's hands at the end of the financial year of £21 3s. 1d. In the report it was pointed out that the financial position of the Association was not of the rosiest; and certainly the Executive Committee had had to be extremely careful with regard to expenditure. This state of affairs, if it continued long, would have a detrimental effect on the working of the Association. Therefore it might be necessary to consider next year, ways and means, by increasing the membership, or, on the other hand, by increasing the subscription. The latter course, he hoped, would not prove necessary.

Mr. GEORGE DIXON (Lancaster) seconded the motion, which was carried.

Mr. F. C. BRIGGS (Dudley) proposed that Mr. Shadbolt be appointed their Chairman until the next May meeting. As Chairman of the Executive Committee, he (Mr. Briggs) had been in close touch with Mr. Shadbolt, who had done very good work for them. The Association, as a new organization, had had great difficulties to face; and no doubt it had seemed to some people that they had been "cutting no ice." He could, however, assure the members that since last May they had been ploughing through the icefield; and this had been entirely due to Mr. Shadbolt. They could not find a better advocate.

Mr. J. H. CROWTHER (Wallasey) seconded the proposal, which was supported by Mr. RAMSDEN and agreed to.

The CHAIRMAN said he would be very pleased to occupy the position for another year, because he felt that it would be giving him an opportunity of completing the work which he tentatively undertook—that was, to bring this movement to a successful issue. He did feel when he was asked to take the chair that he occupied a rather unique position, having been on both sides of the hedge, and being at the present time in a somewhat independent state.

On the proposition of Mr. DIXON, seconded by Mr. J. MOGFORD (Briton Ferry), Mr. W. G. S. Cranmer, of Willenhall, was re-elected Treasurer.

The CHAIRMAN remarked that Mr. Cranmer had rendered really substantial service to the Association ever since its inception.

Next the Hon. Auditors (Mr. Vincent Hughes, of Smethwick, and Mr. R. J. Rogers, of Birmingham) were re-appointed, on the motion of Mr. MOGFORD, seconded by Mr. DIXON.

The CHAIRMAN said that now they were working under their constitution, the different districts elected the members of Council; and in this way nominations had been made; but to put the matter in order, it was necessary that the meeting should now confirm them.

Mr. W. G. S. CRANMER (Willenhall) proposed the confirmation of the election of these members, pointing out that they had all of them had some experience of the work. He himself had been connected with the movement from the beginning; and he was very keen that the work should go on. He thought they might hope that in course of time, in spite of the uphill task that had faced them, the Association would flourish, and do what it was intended to do. He had mentioned on several occasions that they did not want to be thought selfish. The idea was not only that they should ask something, but that they should be willing to give something. What he meant was that though they asked that the position of many members of the industry should be improved, at the same time they were hoping that the Association would help the members to improve the service given by them to the industry. The representatives, so far as they had already been nominated, were as follows:

District.	Members.	Assistant Members.
Midland	F. C. Briggs F. G. Shaw	B. J. Bell —
Manchester	G. Dixon	J. Bridge
Northern	W. M. Galleway	T. A. Seagrave
Eastern	—	C. G. Howard
Southern	—	L. C. Geer
South Wales	J. Mogford	F. C. White
South-Western	—	J. R. Love
North British	J. Wilson	J. Wilson

Mr. F. G. SHAW seconded, with the remark that those who were at present on the Executive Committee, so far as he knew, put their very best into the work. It had been a particularly hard task to get things moving at all. There were a great many difficulties connected with the organization of such an Association as theirs. To begin with, their aims and objects were of the very greatest importance, and yet the members concerned were not at all numerous. The number of engineers and managers in the British Isles, he thought, who would be eligible for membership was considerably less than a thousand. But there was very great interest still being taken in the Association, and he felt sure they were on the right lines.

The nominations were confirmed.

On the proposition of Mr. BRIGGS, seconded by Mr. W. M. GALLEWAY (Whitby), Mr. A. E. Broadberry, of Tottenham, and Mr. Charles Wood, of Bradford, were appointed trustees.

ALTERATIONS OF RULES.

The CHAIRMAN said the next item was the alteration of the rules. They were at the moment working under the draft rules submitted at the last annual meeting. These rules had been very carefully gone through again and again during the year by the Executive; and the proposed alterations had been considered by the Council. Under Rule 6, however, it was provided that "no special business shall be transacted at any general meeting unless there be present at the commencement of the business not less than fifty corporate members entitled to vote." This number they had not with them then. The adoption of the amended rules was rather an important matter to stand over until the next annual general meeting. The best course would be to adjourn the meeting for as short a time as possible.

Mr. BRIGGS pointed out that the rules had been amended on lines suggested by the District Sections, and if they adjourned

the meeting the rules could be passed whatever number of members might then be present.

After some further discussion, it was resolved, on the motion of Mr. SHAW, seconded by Mr. CRANMER, that the meeting stand adjourned to a little later in the day; and on the resumption of the proceedings,

Mr. BRIGGS proposed the adoption of the amended rules. He explained that Rule 3, which provided that no member should apply for any position where a minimum salary was not stated, had been deleted. The terms "senior member" and "junior member" had been dropped out; and full membership had been divided into "members" and "associate members," the classification being largely a question of subscription. The portions of Rule 4 bearing particularly on this matter are as follows:

Members shall be over 25 years of age, and hold, or have held, the position of engineer or manager of a gas undertaking with an annual make of gas of over 25 million c.ft., or a position of technical responsibility in the manufacturing, engineering, or distribution departments of an undertaking with an annual make of over 200 million c.ft.

Associate members shall be managers of small works with an annual make of 25 million c.ft. or under to 15 million c.ft., all other technical officials not specified in the paragraph preceding, and pupils.

Managers of works with an annual make of under 15 million c.ft. may be admitted at the discretion of the General Council.

The entrance fee for members shall be £1 1s., and the annual subscription shall be:

For engineers and managers in undertakings of 100 million c.ft. annual make and over, and departmental chiefs in works of 500 million c.ft. annual make and over, £2 2s.

For all other members, £1 1s.

The entrance fee for associate members shall be 10s. 6d.; and the annual subscription shall be 10s. 6d.

Associate members transferred to the class of members shall pay a transfer fee of 10s. 6d., in addition to the appropriate increased subscription.

The rule relating to the government of the Association had been put on a better basis, whereby each area would elect its own representatives on the General Council which controlled the Association. The Association was divided into District Sections, and they could elect a Committee and Hon. District Secretary. This would put the organization on a sound footing. Associate members could now be represented at all general meetings by delegates, because it was recognized that they could not attend at the time of the annual meeting of the Institution of Gas Engineers. The rule dealing with the alteration of rules had been revised, to make it certain that all members should have adequate notice of any proposed alterations before they could be passed. The rule in question was Rule 12, which would now read:

Any alteration in or addition to these rules must be submitted by the General Council to the corporate members at a general meeting, and shall be approved by three-fourths of the corporate members present and voting, or in the event of a poll being demanded in accordance with Rule 6, by the same proportion of corporate members voting by postal ballot.

Notice in full of any proposed alteration of rules must be lodged with the General Secretary not less than 21 days before the date of such general meeting.

Alterations to rules shall be submitted in full by the General Secretary to all corporate members, with the notice of the general meeting at which they are to be proposed.

These alterations had all been in the hands of members since May last.

Mr. SHAW, in seconding, made reference to the large amount of work done by Mr. Briggs in putting the rules into shape. It was only right that this should be acknowledged.

Mr. A. S. BROOK (Lisburn) expressed the opinion that, if they wanted to make progress, it would be necessary to fix a higher subscription than the one mentioned. More money would be required if any really effective work was going to be done.

The CHAIRMAN: That is a very appropriate remark. The position is obvious.

The altered rules were then unanimously adopted.

The CHAIRMAN said he thought he ought to tell them of the amount of work done by the Executive since the time they were appointed. They met practically monthly, at great personal inconvenience. Mr. Briggs, in particular, as Secretary, had had a large amount of work. Thanks were due to the Executive for what they had done; and he hoped their efforts would have a successful issue. He proposed a vote of thanks to them.

Mr. RAMSDEN seconded, and asked whether the Executive could not secure more publicity, as to what they were doing.

Mr. BRIGGS replied that they wanted to get publicity; and the Technical Press published a *résumé* of the Executive meetings.

Mr. GALLEWAY, moving a vote of thanks to the Chairman, said that from what he had seen of Mr. Shadbolt he was convinced that whatever he took in hand he put his heart into. The present position of the Association was largely due to the interest he took in matters of this kind.

Mr. CRANMER seconded the vote, which was acknowledged by the CHAIRMAN.

The meeting was then brought to a close.

The half-yearly meeting of the Wales and Monmouthshire District Institution of Gas Engineers and Managers, which was to have been held to-day, has been postponed till the 27th inst.

SPEEDING-UP WATER GAS PRODUCTION.

By A. O. JONES, of London.

THE present tendency towards a lower standard of calorific power, and the high prices of labour and materials, particularly coal and gas oil, are concentrating the attention of engineers and managers more and more on the production from a ton of coal of the maximum quantity of B.Th.U. in the form of mixed coal gas and water gas.

The continued increase in the number of works where total gasification plants are installed shows this drift of opinion; and other engineers are overhauling their carburetted water-gas plants for producing plain water gas in order to increase the B.Th.U. obtainable from a ton of coal while reducing the cost of manufacture. In the latter case, in order to overcome the disadvantages of making coal gas and water gas in separate plant units, arrangements are being made for the quick transfer of hot coke from retort to generator, and where possible for placing the water-gas plant under the same roof as the retort-settings. In addition to this, waste-heat boilers are being added to the water-gas plant to increase the over-all efficiency; and, in general, more attention is being given to operation details.

Those who have been in the habit of making carburetted water-gas know that when results show the generator fuel consumption down in the neighbourhood of 27 lbs. of carbon per 1000 c.ft. of gas made, they are getting near maximum efficiency; but many managers are still doubtful as to (1) what effect the change-over to uncarburetted water gas would have on fuel consumption, (2) how much waste heat should be recoverable, and (3) what, if any, alterations should be made in plant manipulation. It is now a recognized fact that steaming retorts is a wasteful method of manufacturing water gas, although a small amount of steam admitted to retorts has a beneficial effect on the working of the charge in other ways, so it need not be discussed. But further consideration may be usefully given to the three items enumerated, in order to see if any progress can be made.

(1) WATER GAS WITHOUT ENRICHMENT.

When discontinuing carburation of water gas, the fact that a certain volume of oil gas is withdrawn and more water gas has to be made to take its place, seems to point to a larger fuel consumption when water gas alone is being made; but when comparing water-gas with carburetted water-gas making, the following facts must not be overlooked:

(*a*) About 5400 B.Th.U. are lost in the gasification of every gallon of oil.

(*b*) About three times as much heat is lost by radiation and convection from the carburettor, superheater, and connecting pipes, as compared with the losses from the generator, on account of the larger surface exposure.

(*c*) Heat is carried away by the extra blast products liberated in producing the extra heat required by these two items.

From a heat balance calculation relating to a comparatively small set (600,000 c.ft. per 24 hours), when making (1) water gas, and (2) carburetted water gas, it appears that the distribution of heat among the chief items would be somewhat as follows, in terms of carbon per 1000 c.ft. of gas made:

BLUE WATER GAS.

Carbon delivered to the gas as carbon monoxide	12·68
Net loss due to water-gas reaction	5·68
Loss by heat carried away by blast products	3·65
" " " gas produced	1·69
" radiation and convection from generator shell	0·55
" sensible heat in the ashes, &c.	0·05
Consumed in raising steam for blower engine	1·50
Total carbon per 1000 c.ft. of gas made	25·80

CARBURETTED WATER GAS

(*Using 2 Gallons of Oil per 1000 C.Ft.*).

Carbon delivered to the gas as carbon monoxide	10·47
Net loss due to water-gas reaction	4·69
Loss by heat carried away by blast products	4·10
" " " gas produced	1·92
" radiation and convection from generator, &c., shells	2·19
" gasification of oil	0·74
" sensible heat in ashes, &c.	0·05
Consumed in raising steam for blower engine, oil-pump, &c.	1·80
Total carbon per 1000 c.ft. of gas made	25·96

These figures show, within a fraction, the same fuel consumption when either kind of gas is being made; but to attain such an approximation in practice, attention must be given to the variations in plant manipulation which are necessary. Some of these will be dealt with under item (3).

(2) UTILIZATION OF WASTE HEAT.

Mr. E. G. Stewart, in his excellent paper last year [see "JOURNAL" for March 30, 1920, p. 750], gave a useful account of a waste-heat boiler for water-gas plants; and the steam raised in this way is a real gain in reduced fuel consumption and over-all efficiency of the plant, provided it is confined to the use of what may be called legitimate waste heat. On the other hand, such an

adjunct to the water-gas plant must be carefully watched, so that the waste-heat boiler shall not become a wasteful-heat boiler. The function of a water-gas generator is to make water-gas, and not to raise steam by the combustion of carbon monoxide in a waste-heat boiler.

Strictly speaking, the only heat which can be legitimately called waste heat is that contained in the sensible heat of the blast gases and water gas leaving the generator. This, in terms of fuel, is about 5 or 6 lbs. of carbon per 1000 c.ft. of water gas made, and equal to an evaporation of (say) 40 or 50 lbs. of steam. The presence of carbon monoxide in the blast products is, theoretically, a mistake, and in practice should only be considered as a legitimate source of waste heat when the gas operator cannot adjust his conditions to avoid its formation. If these conditions are such as to show 2 p.ct. of CO in the blast products, the working of the plant should be investigated as being unsatisfactory; first, because the formation of CO during the blast means lower temperatures for gas-making, and, secondly, because coke as usually supplied to water-gas generators is a more expensive fuel for steam-raising than breeze sweepings from the coke yard. In most gas-works there is an ample supply of the latter fuel; and where there is not, it is better policy and less expensive to use slack or other cheap fuels than to work the water-gas generator with blast products containing excessive quantities of CO.

(3) From Carburetted Water Gas to Water Gas.

The most important variation in the change-over from making carburetted water gas to making water gas, is the altered "blow" conditions required. The discontinuance of oil gasification makes the secondary combustion in carburettor and superheater unnecessary; and the concentration of gas production in the generator itself makes a few degrees of temperature or a few seconds of time vastly more important than they were before, because the combustion during the blow must now be directly and completely to CO_2 and N, with the release of the maximum number of B.Th.U. in the minimum of time in the generator itself, and any appearance of CO in the products is an absolute waste so far as gas-making is concerned.

When making carburetted water gas, the blower delivers only about 70 p.ct. of its output through the generator, and the rest through the carburettor and superheater; but when making water gas the whole supply is available for passing through the generator. This totals about 300 to 350 c.ft. of air per minute per square foot of grate area; and as combustion is direct to CO_2 instead of partly to CO_2 and partly to CO, the result is a quicker release of heat and a higher temperature of combustion. Consequently the length of blow may be shortened and yet provide sufficient heat for the gas-making reactions during a five or six minutes' run.

The fan type of blower usually installed with carburetted water gas plants gives a volume delivery dependent largely on the resistance offered, and their size has been fixed for delivery against a certain average pressure resistance expected in the set. With the alteration of working it may be that when the full air supply has to be delivered through the generator, some of the older blowers may give an insufficient air supply, due to back-pressure, even when clinkering is done more frequently so as to keep a clean open fire. So, in order to get the best machine output of gas, it may be advisable to put in a larger or more powerful blower. A generator should be equal to a production of 1500 to 2000 c.ft. of gas per hour per square foot of grate area, if the air blast, fuel bed, steam distribution, &c., are adjusted to obtain the best conditions of working.

Condition of Fuel Bed.

The ideal blow when making water gas alone (consisting, as stated above, in the release of the maximum of B.Th.U. in the minimum of time) takes place when the fuel is burnt directly and as completely as possible to CO_2 according to the equation:

$$C + O_2 = CO_2.$$

At the high temperatures required for water-gas production, this ideal blow is effected by the use of a high-velocity air-blast, in sufficient quantity to ensure combustion to CO_2 and to prevent reduction of CO_2 to CO, or in the event of CO formation, to provide for its oxidation to CO_2 before it leaves the fuel bed. With a fuel bed about 5 ft. deep, there will be required 300 to 350 c.ft. of air per square foot of grate area in a blow of one minute, in order to approximate to such conditions. The dryness of the fuel, the size of pieces, its distribution evenly in the generator, and the frequent removal of clinker, all require constant attention so as to maintain good results.

It is an advantage to have the fuel screened, using only 3 in. to 4 in. pieces—*i.e.*, not less than about ½ lb. in weight. But if smaller pieces are used, they should be distributed in such a way as to give a uniform texture throughout the fire, to avoid "patchiness," which results in parts of the fire being dead, while "blow holes" in other parts form channels for the escape of air without proper contact with the hot fuel. Dust and small pieces of fuel are apt to be blown out of the generator entirely when using the high-velocity blast which is here recommended. Clinkering should be done as frequently as every five hours, or less if necessary, to keep the fire unobstructed and free from "patchiness" or "clinker-mats;" for although frequent interruptions appear to be encroachments on gas-making time, it will be found that the output of gas per hour, both as regards volume and quality, will be increased by the improved conditions of the fire, and the reduction of back-pressure.

Temperatures.

The effect of temperatures on CO formation can be counteracted within wide limits by regulation of the flow velocity of the air during the blow, and of the steam during the run; and an authoritative investigation is urgently required stating the relation between temperatures and high-velocity working, because high temperatures worked in conjunction with high velocities give the highest capacity and most economical working results in a water-gas generator. With present methods of working, there is a practical limit set to gas-making temperatures by the trouble with hard clinker formation. Otherwise the higher the temperature the better during the run. This is shown by the fact that the proportion of steam decomposed at 1100° C. is trebled at 1300° C. if the same velocity of steam flow is maintained, and the same proportion which requires four seconds contact to decompose at 1100° C. can be decomposed by half a second contact at 1300° C. In other words, the gas making capacity of a fuel bed falls rapidly with a decrease of temperature. Consequently there is wisdom in the practice of reducing the steam towards the end of the run.

Furthermore, the rate of production of a good quality gas is so slow at 1100° C. in single generator work, that it is probably better to cut-off the steam when the temperature falls to 1100° C. and so maintain a higher average temperature with its much higher gas output capacity. In fact, Clement and Adams, in the conclusions drawn from their experiments, state that the enormous increase in rate of gasification with rise of temperature suggests the desirability of operating (with preheated blast) at 1500° C. or more, and removing clinker as a slag in the molten state, in the manner of blast-furnace practice. Such a course would get rid of the clinker troubles so prevalent where cokes from poor coals are being used. But before its adoption, the question of suitable fluxes should be studied, with a view to their mixture with the fuel to assist the melting properties of the clinker. On the other hand, investigations with fairly high-velocity blast (about a quarter of a second contact), show that during the blow, at temperatures up to 1100° C. there is less than 1 p.ct. of CO in the products; but above this it gradually increases, till at 1300° C. over 5 p.ct. of CO appears in the products. And if this is remedied by still further increasing the blast velocity, it is limited by the possibility of blowing pieces of coke out of the generator.

Opposing Conditions to be Reconciled.

Thus, to obtain increased speed and efficiency in gas production during the run, a temperature of 1300° C. and even higher, is desirable. But with single generator work, using air-blast, there is a reduced blow efficiency when working at such high temperatures, due to the higher proportion of CO in the blast products. This difficulty of opposed requirements may be avoided, either by using oxygen (thus eliminating the blow, and making gas production continuous), or by using two generators in series (or a twin generator) with intermittent air-blast, and operating them in such a way that whichever is working in the first position shall be blown to give a temperature of 1300° to 1500° C. and the blast products, containing a relatively high proportion of CO, shall then pass to the second generator, where the fuel is at a lower temperature, and the blow regulated to give only CO_2 in the final blast products.

When the policy of higher temperature working is adopted, and the difficulties of clinker removal in the form of slag have been overcome, it will be better to utilize waste heat in preheating the air supply during the blow and superheating the steam during the run, because cold air and low-temperature wet steam have a cooling effect on the fuel bed, and if the generator is relieved of this extra work, its capacity will be increased considerably as a gas-making machine.

COMPLETION OF THE ASTORIA (NEW YORK) GASHOLDER.

By Robert E. Livingston, of New York City.

Yesterday [Sept. 24] the last drop of 14,200,000 gallons of water, which has been flowing all the week from an 8-inch main, gurgled into the immense 15,000,000 c.ft. gasholder of the Astoria Light, Heat, and Power Company at Astoria, Long Island. Two small snub-nosed punts and a flat-bottomed row-boat—the latter probably after a misspent but gay young life on Flushing Bay—took a parting look at the light of day before the last steel plate and the last manhole covers were bolted down; and they began a long sentence on the Stygian black lake, 300 ft. across, that fills the tank of the gasholder and under the equally inky black dome that represents the crown.

A circular pool, 300 ft. across, is no inconsiderable ducking pond, as the small urchins of Astoria discovered last summer when excavations were begun upon the pit to hold the 1,200,000 lbs. of concrete and the 1,000,000 lbs. of steel reinforcements which went into the bottom and retaining wall of the new gasholder tank. The flooring of the tank, which is laid on the bed rock, is possibly not over 18 in. in depth; but the cylindrical wall which must withstand the weight of 48 ft. of water is 9 ft. thick at the bottom and 5 ft. thick at the top. It stands 50 ft. high, and is constructed of the above-mentioned couple of million pounds of steel and concrete.

Within the concrete tank rest the sections of the holder, huge

cylinders of $\frac{5}{16}$-in. steel plate, 48 ft. 6 in. high. There are five of them. The inner one, known as the crown section, carries the steel dome that forms the top of the holder. Its plating varies from $\frac{3}{16}$ to $1\frac{1}{8}$ in. in thickness from the centre to the circumference, and the centre of the dome rises 24 ft. above the edge of the section to which it is attached. The compression developed at the edge by the lifting power of the gas upon the bulging crown amounts to 1000 tons. To withstand this tremendous pressure, and prevent the edge from crumpling like a paper cup, the joint between the dome and perpendicular section is reinforced with a massive curb, trussed on the inside and strengthened with heavy plates on the outside.

Substantial and earthbound as this structure looks, it is really very light in comparison with the tremendous lifting surface which it exposes to the gas—some 60,000 sq. ft. Were a sufficient number of rubber tubes run through the water and under its edge, and a sufficient number of persons with no more than average chest expansions asked to blow into the tubes, it would slide-up its guide-frame with a great deal less exertion on the part of the blowers than a small boy exhibits in puffing-up a paper bag. The pressure which the holder exerts upon the gas is but $\frac{1}{2}$ lb. to the square inch. Any pressure of gas or air greater than this will inflate it. The total weight of steel in the crown section and guide-frame of the Astoria holder is but 4000 tons, no small proportion of which is in the guide-frame which is attached to the edge of the concrete tank and is not lifted by the gas.

Not only is the holder itself comparatively light, but it is top heavy. When buoyed-up by the gas, the crown section (if it had free play) would immediatety turn turtle. Set as it is inside the other sections and tank, it would wedge itself, doing irreparable damage to itself and them. To prevent this, a shelf is constructed around the inside lower edge of the perpendicular side of the crown section, on which are bolted an unbroken series of 700 lb. concrete weights, 1200 in number. This additional 800,000 lbs. placed at the lowest possible point on the crown section lowers its centre of gravity below its centre of buoyancy, thereby putting it in stable equilibrium as a floating body. As the holder is inflated with gas and the inner section rises to the point where the cup which runs round the lower outer edge of its side engages the grip which runs around the upper inside edge of the next section, and lifts that section, the stability of the whole is further guaranteed by goose-neck arms which bear upon the uprights of the guide-frame with rollers, and keep the floating crown and each of its dependent sections at an even distance from the sides of the tank and from each other. And also make it impossible for them to rotate—not an improbability, as both they and the tank are perfectly round.

Furthermore, besides being both light and top heavy, a gasholder is fragile. Despite its elephantine and monstrously substantial appearance, it is not unlike a gas balloon, except that, unfortunately, it is inelastic and instead of contracting when not inflated would crumple. It could not stand by itself. The side sections sitting up on their edges and protected and braced by the tank which is as solid as the rock itself, might do well enough, but the crown if uninflated and unsupported would cave-in. To prevent this, the framework upon which in the course of construction the crown plates were laid, and which is therefore exactly the proper shape to support it, is allowed to stand permanently on the floor of the tank. Although made of wood, it lasts indefinitely —being entirely unexposed to the air. The lower part of it will stand in the water, also a permanent fixture in the holder, and the upper part will be in the gas, which is not detrimental to wood. When the holder is inflated, the gas supports the crown just as it would distend the rubber of a toy balloon; when the holder is deflated, the more or less flexible crown drops down and rests upon the framework.

All the foregoing data lead to the conclusion that the designing, erection, and adjustment of a 4000 ton gasholder capable of holding 15,000,000 c.ft. of gas without leaks, made so light that it would collapse if unsupported, and yet so heavy that any misadjustment would cause it to rip itself apart—is no simple problem. It is vastly more complicated and delicate than the job of erecting a rigid and immovable steel tank, such as is used for storing oil. The fact that the holder is in almost constant motion, and that this motion must be free and smooth, as well as accurately regulated, makes miles of engineering difference between the building of a great gasholder and the building of any other kind of steel structure.

The job of building one of the largest gasholders in the world (the other largest is the twin of the newly completed holder and stands alongside of it at the Astoria Company's plant) is considerably more than the cutting-out of the steel plates and riveting them together with 2,500,000 rivets, which is the number used at Astoria. The bills show the difference. The new holder cost the Astoria Light, Heat, and Power Company $1,500,000.00.

This is in spite of the fact they were able to economize very materially in the early stages of the construction, owing to a favourable location. The bedrock lies near the surface at the point chosen for the holder. The excavation necessary to give a circular pit, 300 ft. across and 50 ft. deep, would have amounted to something between 300,000 and 400,000 c.yds. But it was not necessary that the tank should have a flat bottom. The construction engineers therefore confined their digging operations to a circular trough 50 ft. deep and wide enough to accommodate the 9 ft. concrete wall of the tank and the telescoped sections of the holder, which had to rest inside the wall. Inside this trough they left the native rock standing in the shape of a huge cone, cut off flat at the top. The circular flat top of the cone is 100 ft. in diameter, and the incline which runs down to the trough is 146 ft. long. Thus the excavation was reduced to about 200,000 c.yds. The bedrock was then covered with a comparatively thin layer of cement, and the structural framework to support the crown of the holder, both while it was being made and afterwards, was erected upon the cement covered cone. A secondary economy occurred here, as the supports needed were much shorter.

And now re-enter the boats. Before the water was let into the tank, they lay upon the top of the cone, where they had their pictures taken. As the water level is some 3 or 4 ft. above the top of the cone, they are now afloat but not adrift. Each one is tied directly under one of the manholes in the crown. Workmen will be let down through the manholes, the lids replaced, and the holder blown-up with air, not with gas. As the crown section rises above the water, there will come into view the rollers set below its lower edge, extending out beyond its circumference to bear against guide-tracks on the inside of the next section. These rollers have to be adjusted. Then the holder will be blown-up some more; the next section will be lifted; and its rollers will come above the water. So for the next few weeks the expert mechanicians of the Construction Company will be paddling around in the row boat and two punts in 15,000,000 c.ft. of midnight blackness. It would take a very big light—one much larger than those they will carry—to make much impression on the absolutely air and water and light proof density of that blackness.

When every adjustment has been made, the boats will be tied-up under the manholes; the workmen will depart; the manhole covers will be bolted-down; and the air will be let out of the holder and the gas pumped in. Then for many, many years the row-boat and punts will have only themselves for company; for the holders are built to work on and on for long periods, without any interior attention.

The placing in operation of this holder by the Astoria Light, Heat, and Power Company marks the completion of an addition to the Astoria plant costing $7,500,000, and capable of producing 30,000,000 c.ft. of gas a day, in addition to the 50,000,000 c.ft. produced by the original plant. This second unit to be erected at Astoria is a part of a contemplated plant to consist of six such units; and even as the plant stands to-day, it is the largest gas-producing works in the world.

PERSONAL.

Mr. ARCHIBALD P. MAIN, the Vice-Chairman of Messrs. R. & A. Main, Ltd., and Thomas Glover & Co., Ltd., sailed last Saturday for Australia in the Royal Mail S.S. "Osterley," for a tour embracing the firms' world-wide business connections.

Mr. and Mrs. G. L. SWALLOW, of Newcastle-upon-Tyne, celebrated their Golden Wedding last Monday. Mr. Swallow has been Manager of the Elswick Gas-Works since 1898, and will, in August of next year, complete fifty years service with the Newcastle-upon-Tyne and Gateshead Gas Company.

Mr. DAVID V. REID, of Port-Glasgow, nephew of Mr. David Vass, of Perth, who has been appointed Manager of the Huntly Gas Company, Ltd., received his training as an engineer and draughtsman with the Greenock Foundry, and specialized in gas engineering with Messrs. Henry Balfour & Co., of Leven. He served with the Royal Engineers in France, prior to which he was with the Glasgow Corporation during reconstruction work at Dalmarnock, and latter with the Musselburgh Gas Company. At Port-Glasgow, where he was Assistant Gas Engineer, he was engaged as Clerk of the Works, and Inspector of the new gas-works recently erected by the Corporation.

Purification Temperatures.

During the winter of 1917-18, Mr. E. M. Osbourne, of Macon (Ga.), had occasion to visit five different gas plants, all in the South, where, there being so little cold weather, there is naturally no protection provided for purifiers. However, the coldest weather in many years occurred that winter; and all the plants referred to had had short periods of dirty gas, caused by too low a temperature in the oxide purifiers. Therefore he suggests that, though usually cold spells last but a short time in the South, those who have little or no protection for their outdoor purifier boxes should provide some means of keeping the gas going through the purifiers round about 60° Fahr. Writing on the matter, he recalled an instance in which dirty gas was experienced at Alabama during a cold spell some years ago. It happened in this case that the boxes were housed; but the doors and windows were left open. When the foul gas came along, the doors and windows were closed, and steam-jets put into the seals round the boxes. The temperature of the entering gas was at that time about 45°. Within an hour, the test for sulphur was better; and in two hours, quite an improvement could be noted. Within half-a-day, the gas was almost clean; and by the next morning it was quite right. By studying this cold spell and its effect, it was possible to prevent the recurrence of dirty gas from low temperature.

THE REFRACTORY MATERIALS SECTION OF THE CERAMIC SOCIETY.

The Autumn Meeting of the Refractory Materials Section of the Ceramic Society was held on the 6th and 7th inst., at the Institution of Mechanical Engineers, Storey's Gate, Westminster, when a varied programme was carried out, under the chairmanship of Lt.-Col. C. W. THOMAS (the President).

The first paper was on the "Refractory Materials of the London Basin," by Mr. Henry Dewey. The London Basin comprises the country lying between the Chiltern Hills and the North Downs, extending eastwards to the sea. The northern and southern boundaries are formed by the chalk, which extends continuously from one to the other, overlaid by Tertiary and Pleistocene deposits, including in ascending order the Thanet Sands, Woolwich and Reading Beds, London Clay, Upper London Tertiaries, and alluvial brick earths resting upon alluvial gravels. The only refractory materials of importance from the chalk are the bands of flint nodules which are used in some potteries. The Thanet Sands supply materials, at Beddington (near Croydon), which are used for making lime-sand bricks; and near Erith the more clayey bottom portion of the Thanet Sands has long been used as foundry sand for moulding. The Woolwich and Reading Beds, London Clay, and some of the Upper Tertiaries, as well as the alluvial brick-earths, furnish materials for making bricks, tiles, &c.; but few of them could be reckoned among true refractories. A loamy sand belonging to the Woolwich and Reading Beds, and occurring in a limited area at Epsom and Ewell, was formerly dug for moulding sand for goldsmiths' work. In recent years it has been used for making refractory wares for use at many gas-works in London and elsewhere. The London Clay has been worked extensively, not only for making red bricks, but also for Portland cement. The alluvial brick earths formerly supplied most of London's building bricks.

The next item was Mr. J. H. Marlow's paper on the "Marlow Gas-Fired Tunnel Oven." This comprises a simple, but effective, producer, a system for pre-heating the air and superheating the gases before combustion takes place, and an exhaust to draw the heat through the centre of the tunnel (and not along the walls), which the author considers the necessary features for the application of producer gas to heat tunnel ovens, &c. The exhaust, which consists of a system of pipes, is regarded as the governing feature. A temperature of 1140° C. can be reached in 48 hours from the time of lighting the fire in the producer; and the temperature can be either raised or dropped 100° C. in three hours. Mr. Percival J. Woolf next read a paper entitled "Combustion of Oil Fuel;" and the last of the morning papers was that by Dr. A. Granger, on "Alumina, Corundum, and Especially Alumino-Thermic Corundum, as Refractories."

In the afternoon, Mr. H. S. Houldsworth read a paper by himself and Prof. J. W. Cobb, on the "Reversible Thermal Expansion of Silica." The experiments showed that little change took place in tubes of vitreosil (fused quartz) by repeated heatings to 1000° C., or by four hours' burning at 1150° to 1170° C. After firing for three hours to Cone 14, some tridymite appeared; while heating for 2½ hours at 1510° to 1555° C. resulted in from 30 to 50 p.ct. of the vitreosil being transformed into tridymite, according to the indications of refractive index. In all the other experiments cristobalite had been the form of silica, produced in quantity at high temperatures; and in this case the tridymite obtained may be an unstable form. In the presence of 5 p.ct. of soda, heating at 700° C. for two hours transformed amorphous silica almost completely into cristobalite, though pure silica prepared from silicon fluoride, and vitreosil, were unaltered by similar treatment. The cristobalite produced at 700° C. from amorphous silica in the presence of soda was changed largely into tridymite by heating to 1170° C., or to Cone 14. On the other hand, cristobalite was the chief product obtained by heating pure amorphous silica (prepared from silicon fluoride) to the corresponding temperatures.

Vitreosil was not changed after firing for 2½ hours to 1170° C.; but some tridymite was present after heating to Cone 14, and still more after heating to 1510° to 1555° C. The transformation of the cristobalite (first obtained by heating precipitated silica in the presence of soda to 790° C.) into tridymite on heating at 1170° C. gave support to Fenner's view that tridymite is the most stable form of silica at the latter temperature. The non-production of quartz was remarkable, considering its wide distribution and the great rarity of cristobalite and tridymite in Nature. Quartz is denser than the other crystalline forms of silica; and possibly pressure, as well as appropriate heat treatment, would facilitate its formation. Firing Meanwood ganister without bond to Cone 9 repeatedly, or subsequently heating to Cone 14 for two hours, caused only a small part of the quartz to be converted into cristobalite; but no tridymite was produced. On firing to Cone 20 for two hours, the quartz was completely transformed, mainly into cristobalite, but partly into tridymite. Meanwood ganister with plaster bond, fired to successively higher temperatures up to Cone 9, showed a decreased expansion between 550° and 600° C. without the appearance of other expansions such as would indicate conversion of quartz into tridymite or cristobalite. A subsequent firing at Cone 15 for two hours showed conversion of part of the quartz into cristobalite. Subsequent firing for two hours at Cone 19 showed that the quartz had been converted largely into tridymite and cristobalite. Welsh quartzite, on firing to Cone 06 showed only a small permanent expansion, and was still unconverted quartz. Firing to Cone 9 converted part of the quartz into cristobalite; the conversion being considerably increased on firing for two hours at Cone 14, and completed after further heating at Cone 20 for two hours. But no evidence of the conversion of the quartzite into tridymite was observed.

An important point bearing on furnace practice is that, with bricks in which the quartz had been converted into cristobalite by hard firing, no strain and danger of fracture would result from fluctuations of temperature between 1000° and 300° C., after the 300° C. had been once attained; whereas with lighter burned bricks containing quartz, strain would always result below 600° C. Flint with a lime bond was converted with comparative ease on heating into cristobalite; the change being almost complete at Cone 9, and complete at Cone 14. A specimen of silica brick made from Welsh quartzite, fired at Cone 16, showed the large cristobalite expansion (between 200° and 300° C.) and some quartz expansion (between 500° and 600° C.). Another brick made from Yorkshire quartzitic pebbles showed the cristobalite expansion, but not the quartz expansion. A silica brick (made from Welsh quartzite) after long use in a coke-oven had an innermost exposed layer which was an impure glass with a steady expansion only half as large between 15° and 100° C. as that of the rest of the brick, this latter being cristobalite with very little quartz or tridymite.

Blowers for Cleaning-Out Service Pipes.

In a paragraph appearing on p. 542 of the "JOURNAL" for Sept. 7, it was stated that, according to the "American Gas Journal," the Atlanta (Ga.) Gas Company had recently designed and put into operation a "blower for removing naphthalene from the pipes," which had proved much more efficient than the old hand apparatus. The purpose for which the apparatus was provided was, however, Mr. R. C. Congdon (the Manager of the Gas Department of the Georgia Railway and Power Company) writes to point out, mis-stated. The blower for cleaning out service-pipes was not, he says, designed for the removal of naphthalene at all. It is, instead, an apparatus to replace the old hand-pump which was used to remove the rust accumulations from the pipes. So far from being unable to prevent naphthalene from causing trouble in the distribution system, Mr. Congdon says he believes that his Company were one of the first, if not the first, to "bid farewell" to naphthalene troubles. This was back in 1904. They do not, however, attempt the removal of all naphthalene from the gas, as it is not found to be necessary. Naphthalene that causes no trouble in the gas, he adds, should remain there, as it contributes to the heating value of the gas. In connection with the Company's work on naphthalene removal, a number of the largest undertakings in the States were consulted, and it was found that it was not their custom to remove all the naphthalene which might be present.

The Brown Oil Shale Retort.

The Index Shale Oil Company, of De Beque (Col.), are erecting a retort designed by Mr. H. L. Brown, of Glen Ridge (N.J.), which it is hoped will prove highly successful in low-temperature practice. It is tubular, horizontal, and with a positive feed, but with no moving interior parts. It is constructed in three sections, with stuffing-boxes between; and one or more sections can be either dropped or added as practice or the results desired may demand. The material is broken to pass a 6-in. ring, and is carried forward, as the retort itself revolves, by a fixed device which, while ample to move the shale steadily on its way, leaves a clear centre space, preventing any sticking or bridging. The combined effect of tumbling and heat, says Mr. F. P. Webb, in describing the installation, is that of a ball mill, breaking-up any hydrocarbon material treated very quickly, and delivering the residue in a finely powdered form. Commercial uses have been found for this shale residue. The capital cost per ton of material treated is expected to be far below that of other apparatus; while, among other claims, are the greatest flexibility at all stages, and perfect heat control at all times. Thus the same retort will handle a wide variety of material. Gases are taken off from each section as made; and at the stuffing-boxes steam-curtains are introduced, preventing the gases from the various stages entering other zones. While no new mechanical principles are involved in this simple apparatus, it is urged that it does consist of a clever combining of old and proved practice.

Society of Chemical Industry.—The latest list of members elected to the Society of Chemical Industry includes the names of Mr. Frederick E. Mills, of the Brentford Gas Company, and Mr. Leonard Silver, of the Kensal Green works of the Gas Light and Coke Company.

The Scheme for the Formation of a Private Wagon Owners' Association.—The Committee appointed at the meeting held on Aug. 8 to inquire further into this proposal and to report on what particular basis an Association should be formed, have met on several occasions and considered these matters. A further meeting of owners will be held at the Cannon Street Hotel (to hear the report of the Committee) on Monday next at 4 o'clock.

SCOTTISH JUNIOR GAS ASSOCIATION.

(WESTERN DISTRICT.)

OPENING MEETING, OCT. 15.

PRESIDENTIAL ADDRESS

of

James Cubie, Glasgow Corporation Gas Department.

Gentlemen,—In the preparation of these notes, an endeavour has been made to introduce subjects likely to create discussion, and perhaps broaden our outlook on topics. Some of the points may seem obvious and commonplace; but, nevertheless, they need continuous reiteration, as, if there is anything at all in them, the more often they are brought to our notice, the greater the benefit to the industry as a whole.

INTERCHANGE OF IDEAS.

Perhaps never before in the history of the gas industry has the necessity for the interchange of ideas, with their far-reaching results, been so paramount as to-day. This point was emphasized by Mr. James Dickson, in his presidential address to the North British Association of Gas Managers last month; and it is evident the different Gas Associations throughout the country represent the best field for attaining this objective.

While the necessity for, and the benefit of, systematic study is admitted, membership of Junior Associations, coupled with attendance at classes on gas subjects, will most assuredly sustain our interest and be of invaluable assistance to us in our studies. On the other hand, those who (as it were) have finished their scholastic days it will encourage in their work, and provide with many opportunities for improving their general knowledge in gas affairs.

There are few industries so fully reprezented by Associations as the gas industry; and so long as the members of these Associations, without self-interest, meet for the interchange of ideas, and keep the spirit of reciprocity in the forefront, there need be no fear that development along the right lines will follow—bringing in its train permanent benefit to the industry and the consumers whom we have the pleasure of serving.

ASSISTING THE JUNIORS.

In clause 4, sub-clause (*a*) of the "Objects" of our Association it is stipulated that we are "to devise means for helping and extending the technical knowledge of our members." Since the inception of the Association seventeen years ago, the reading of papers and visits to works have been the basis of our programme year after year. That we have not struck out in other directions causes some of us to feel we have been somewhat neglectful. We cannot, however, overestimate the benefit which past and present members have derived from the reading and discussing of papers and visits to works; and who will gainsay the fact that these have been stepping-stones to progress in the lives of many of those who now occupy high places in the industry?

But are we to content ourselves by leaving dormant one of the principal objects of our Association? Surely not! If we can devise means for helping and extending the technical knowledge of our members and those outside the province of the Association by the introduction of new channels of study, we shall be paving the way for more intelligent and better service to meet the standard of efficiency expected now, and which will be required of all sections of the industry in the years that lie ahead.

Junior Associations may claim to be one of the best study-circles extant. For this reason we should seek to develop our organization more fully, so that a new interest may be created in our affairs and more opportunities be given to our members to express their thoughts on matters touching on their everyday duties. How is this to be attained?

THE VALUE OF INFORMAL MEETINGS.

For instance, we all know the advantage of informal talks; but, unfortunately, our regular monthly meetings do not lend themselves to this. We must therefore in some way or other, get away now and again from the formalities associated with our regular meetings, and if at all possible provide facilities for those who, backed up by enthusiasm, are keen on devoting, with their fellow members, some of their spare evenings during the week to the study of subjects of current interest.

At the annual meeting of the Scottish Junior Gas Association (Eastern District) in Edinburgh a few months ago, reference was made by one of the members to the fact that country members had not the same opportunities for obtaining technical instruction as those resident in the cities. Whether this be the case or not, if we in the Junior Associations can extend our programme so that, over and above our regular monthly meetings, more opportunities can be given to members of meeting together, we shall be putting within the reach of those in country districts facilities which will be appreciated not only by them but by city enthusiasts.

To this end, suitable accommodation would be necessary for the conduct of meetings. What I have in mind is a small work-room or laboratory (with facilities for demonstration appliances and for carrying out tests in a small way) which would be at the disposal of members on one or two evenings each week during the winter months, where topics of general and current interest could be informally discussed. Each evening at the outset would be in the hands of a leader responsible for the introduction of a subject; and at the close of the debate, members would be at liberty to divert the discussion to other matters on which they might desire the benefit of open discussion. Once a fortnight or month we might be able to secure the services of specialists in different branches of the industry for lectures and demonstrations.

Perhaps we could go further than this and sub-divide our Association into districts, to meet this particular purpose, for the benefit of country members. This could be done by representative members of the Council, in conjunction with managers of gas-works in their own area, making the necessary arrangements for local meetings; and surely it would not be expecting too much to look for assistance in this direction from managers of local gas-works.

The value of such talks and lectures does not require further emphasis, as their homely nature would have far-reaching effect not only in improving knowledge, but in bringing members into closer fellowship, which at the present time seems lacking.

It is understood that some undertakings in the South have for a number of years provided facilities for their employees on lines similar to the foregoing; but in this way, it is only the employees of these concerns (which are generally the larger ones) who benefit, and those who belong to the smaller works have to jog along on their own.

Does it not seem feasible, therefore, that an Association founded for the benefit of all sections, should father a scheme as outlined? But you inquire, "How would a scheme of this kind be financed?"

EXTRAORDINARY MEMBERS.

For some time back, it has been apparent that as members attain certain positions in the industry, although they may acknowledge that our Association has helped to fit them for the more onerous positions they now occupy, their interest in our affairs gradually lessens, until they drop out of membership. This is not to be wondered at, as the Senior Associations may meet their new and larger interests more generally than the Junior Associations. Perhaps we as Juniors have not made much effort to retain their membership, just on account of their entry into a new sphere; but when the education of the junior seems to take a prominent place in the thoughts of the seniors, is it not fitting that the interest of the latter in our Associations should be maintained, and that we should now seek to establish a new section in our Association for seniors who are presently ordinary members, and for past members (now seniors) and others who feel that more than a passive interest in our work would be beneficial to the whole industry?

In the year 1911, we had under consideration the "Classification of Membership;" and arising out of a discussion which took place in regard to an annual subscription from honorary members, the then Hon. Secretary (Mr. David Fulton) moved: "That there be four bodies—viz., members, honorary members, extraordinary members, and patrons." What Mr. Fulton had in mind then is perhaps the essence of what is brought before you now. By the establishment of a new section with the appellative of "Extraordinary Member" we would be providing a suitable branch for seniors which, at the same time, would reserve the honorary section for those whom, by long association with us and for valuable services rendered, we may seek to elevate to that rank of membership. A subscription in keeping with their rank in the Association would, perhaps, without going further afield, produce the necessary funds to maintain a project on the lines of the scheme propounded.

These thoughts, therefore, give you two points in relation to the Association which you may consider worthy of a full debate. I have intentionally refrained from referring to the qualification for ordinary membership, as this is a matter which is to be considered at an early date by representatives from the Councils of the English and Scottish Junior Associations, and, in fact, was some time ago before the Institution of Gas Engineers.

We might now allow our thoughts to travel for a few moments to other themes touching on the industry generally.

THE THERM.

Although it is rather late in the day to offer criticism on the "therm" method of charging (the Gas Regulation Act having been passed fourteen months ago), the apathy of local authorities towards adopting the Act tends to create the impression that, while they have the option, they would prefer to continue charging by volume. Reference was made recently to the fact that out of about 220 applications for Orders under the Act, only two were from local authorities. With only ten months to go, if the remaining companies and local authorities do not bestir themselves, they will run the risk of coming under a compulsory Order.

Perhaps local authorities are not sufficiently impressed with the advantages of charging by the "therm." The "therm" or 100,000 B.Th.U. was fixed as the standard to preserve the relationship between it and our volumetric method of charging, and because of the fact that our existing measuring apparatus would suit the new conditions. Unfortunately, the method of arriving at the number of therms when the whole calculation is shown on consumers' bills, savours of too much elaboration; and the mere fact that no change has been made in the measuring instrument in the premises of our consumers, and that figures extraneous to the meter-index are introduced with the actual consumption in cubic

feet, will probably produce more discontent than satisfaction to the general body of consumers.

Industrial consumers, accustomed as they are to the serious consideration of heat values, should appreciate the change; but the ordinary householder may view it with suspicion. Of course, by recording the gas consumption (in volume) on cards attached to meters, there would be no necessity for showing the volume on the accounts. In this way, consumers would not be faced with a complication of figures on their accounts, and the clerical staff would be relieved of a considerable amount of work. Judging from press reports, the public do not appear to be overjoyed with the new method of charge. However, as one writer sagely put it some time ago, "Let us make a success of the job, whether we are in favour of the heat-unit method of charging or not."

A declared calorific value, with the other sections of the Act made applicable, might have met the case quite satisfactorily for local authorities. What our consumers really want is a fixed standard of quality, and regular pressure; and whether they are charged by the therm or by volume is immaterial to them so long as they get satisfactory results. Even without legislation, a well-managed undertaking would look upon these as obligations on their part.

A COMMON STANDARD HEAT UNIT.

Several references have of late been made to the purchase of coal on its heating value, and Sir George Beilby not many months ago remarked that "if gas undertakings are in the future to be paid only for the 'therms' delivered to consumers, they are entitled to throw at least a portion of the responsibility on the coal owners and miners by paying only for the potential therms received in the coal." For some few years, we have been paying for tons of material of absolutely no gas-making or heating value, bringing unprofitable results to the industry all over the country. But, fortunately, to-day the autocratic spirit that prevailed during these years is no longer evident; and while we had no means of redress during the period referred to, we are now in the happy position of being able to make our own selection of coal as in pre-war days, when we had no reason to grumble about the quality of supplies—the power of refusal of inferior material lying in our own hands. If our purchases in future are made on works' analyses, then we ourselves become dictators, as it is very unlikely that any concern would accept fuel inferior in quality to the analyses of the coal on which contracts had been made.

Except for the introduction of a common comparative heat unit standard, and that we have no guarantee that the conditions which prevailed during control will not recur, the necessity for the heat-unit basis of charge for coal does not seem clamant. When the whole industry comes to think in therms, however, we may find it necessary to prevail upon our coal suppliers to follow our example. A thermic charge for coal introduces a new phase in the whole question of charges according to heating value; and should coal come to be charged on a heating value basis, the time might be ripe, when fixing the unit of charge, for considering a common standard heat unit for gaseous and solid fuels, and electrical energy.

If, on the introduction of a thermic charge for coal, the electricity and gas industries were in favour of a common standard, the thousand-and-one references to the adoption of the one or the other (because of lower cost and the necessity to supplement our arguments with numerous calculations to convince consumers) would disappear, and would permit of a straight comparison between gas and electricity. Of course, it may be said that our own standard has been fixed, and that the electricity standard is no concern of ours. But the fact remains that unless all can be brought into line if coal were sold on its heating value, we should not be much nearer uniformity. For comparison purposes, our unit of charge might easily have been the same as the electricity unit, of 3420 B.Th.U.; but a more general comparison covering all three would no doubt give greater satisfaction.

GAS AND ELECTRICITY STATIONS.

When on the question of standardization, our thoughts are drawn to the offer of the Gas Light and Coke Company to lease ground at Beckton for an electricity station, so that for the benefit of both services the resources of each would be at the disposal of the other. Here we have a fine conception of commercial unity, and of the collaboration of interests which if carried out would be the first step towards an idealism more observed in the breach than in the observance. Perhaps some look upon the proposal as too romantic, and that there is not sufficient range for the two services; but the forward movement in the industrial and domestic affairs of the country which we hope before long to see established, should give ample scope for both gas and electricity without impoverishing either in any way.

It is surprising that local authorities with gas and electricity undertakings have not made more use of the facilities offered in this direction, as the first concern of municipalities is generally for cheap and good service. There are surely possibilities on the lines of the Beckton scheme not hitherto acknowledged in many parts of the country.

MUNICIPALIZATION OF COAL MINES.

A few months ago we passed through one of the most serious industrial crises in the history of the country; and the temporary settlement arranged gave us hope that the particular cause of the trouble had been dismissed from the minds of the miners. However, at the annual conference of the Miners' Federation in August last, it was decided to inaugurate a campaign to educate the workers to the benefit of nationalization. The miners appear to consider that the employers are reaping all the benefit, that they as a class are being victimized, and that unless nationalization is secured, there is very little hope of improvement in their conditions and of cheaper coal for the community.

If we look at the position of the miner to-day as compared with a little over a century ago, we find that he is working under conditions giving him freedom of choice of occupation, a shorter working week, wages equal to if not higher than the best-paid artizan, and (with radical improvements in the underground workings, making his surroundings more comfortable) he is assisted materially in the performance of his duties—conditions which could not be bettered under any scheme of nationalization. The miners by their own organizations have certainly done much to bring about these changes.

While reading some historical notes the other day, I came across a paragraph relating to the conditions of the miners about the year 1799. At that time the miners of Scotland were serfs of the soil and were liable to apprehension as thieves and vagabonds if they went from one place to another, and their services were bartered for between coalmasters in the same way as ponies and materials about the mines. In fact, it is on record that a young coalmaster visiting a friend's colliery recognized the voice of a miner to be similar to those of his own colliers, and he asked the miner how he came to be there. He replied, "D'ye no ken me? It's me yer faither swopped for a pony." The pay at that time was regulated by Act of Parliament at £1 2s. per annum. A sorry state of affairs! The miners have not, perhaps, forgotten those bygone years, and the spectre of serfdom may still haunt them in their quiet hours.

Even though the Government of to-day did not yield to the miners' demands, they will always get the credit of more liberality than that of 1799. We do not wish to get back to those mediæval days; but the dissatisfaction which obtains in the mining industry would almost lead one to think that very little change has taken place since the period referred to. Fortunately we are living in a century when the laws of the land give equal rights of citizenship. Surely the miners do not wish to upset these rights and (by ceaseless effort), because of the exceptional position in which they stood during the years of the war, when their claims were never refused, become a privileged class. As Harold Cox put it when speaking on the subject of "Capital and Labour," there is a middle line between the point where the serf was chained and lashed to where he would become the master or dictator. Beyond this middle line, economic conditions will not permit any body of men overstepping. It is recognized, however, that the miner was never better circumstanced than he is to-day; and there is no doubt the country will require to be many years beyond the transition period before a nationalization scheme for the mining or any other industry can hope to receive sympathetic consideration.

Although we may look with apprehension at the present time on any scheme of nationalization, we have had a good example of Government control during the last few years. There is always the possibility that the ownership of collieries by local authorities would place them on a more satisfactory footing for their supplies than by purchases from coalmasters and merchants. The ownership of coal mines by local authorities has not, so far as I am aware, received much consideration by municipal legislators; but where authorities with the dual services of gas and electricity under their own control, covering large areas, could municipalize a certain number of collieries to meet a portion of their requirements, they would have ample opportunity for a full and unbiassed comparison of direct and indirect methods of supply. There is good reason to believe that by careful selection, and by the utilization of all fuel unsuitable for ordinary gas-works and electricity generating station purposes in coke-ovens either at pit-head or at gas-works, giving a supplementary supply of gas and also more profitable coke and other bye-products, the investment would be a sound one. We would then have the advantage of coal at the cost of production; and remembering that, in Glasgow, every 6d. per ton of coal carbonized represents the sum of £20,000 per annum or about ¾d. per 1000 c.ft. of gas sold, we would be conferring a benefit on the community and getting nearer the lower-priced gas which will in the future, we hope, bring our commodity into general use for industrial and domestic purposes, and rid our atmosphere of smoke pollution.

Is there reason to believe that municipal ownership on these lines would be a leap in the dark? There is the possibility that collieries under the control of local authorities would have the effect of stabilizing prices and conditions in their own districts in an industry which for many years has been in a state of vacillation.

GAS LIGHTING.

Just before the war a great deal was done by lectures and propaganda to advertise the efficiency of gas lighting and its economic and hygienic value; and it was then evident that we were on the sure road to establish our position more securely in this very important branch of our business. Since then, with the exception of the periodical publications of the "B.C.G.A.," very little has been done to popularize gas lighting, with the result that progress has been checked.

Circumstances over which our control was limited during the years 1914-19, when we were working under severe handicaps, proved a thorn in the flesh, and we are to-day no doubt being penalized for the vagaries of the years when gas consumers had

no knowledge of, nor were they at all interested in, what was happening in the gas industry to meet national requirements, which, as we are aware, was the bedrock of lighting complaints.

What has been done by us since the armistice to retain gas lighting and develop new ground? If this question were addressed to the larger gas undertakings to-day, the answers might be very disappointing. In the new housing schemes, many gas undertakings are making efforts to secure the lighting as well as the cooking and heating loads; but in numerous instances it is found that electricity is being adopted for lighting only. However, with this exception, it can scarcely be said that we have been doing much propaganda work. We do not admit that we are outclassed by other illuminants or that the revenue from lighting is of no consequence; nor do we forget that there is a competitor near at hand quite willing to pick up the "crumbs," with the knowledge that small beginnings as a rule develop advantageously. As an instance of this, the following quotation from a recent article in the electrical press may cause us furiously to think:

> "In extending the domestic use of electric power beyond the lighting load, the electric iron should be the thin edge of the wedge —nay, the wedge itself. Its very shape is symbolic."

Just as they (electricity concerns) yesterday got a footing for lighting, so they to-day are out to pick-up another small line, which, as the writer says, "would doubtless act as a silent salesman for other electrical 'gadgets.'" They are not the least bit reserved in their statements, nor are they afraid to show their hand; and yet we would almost appear to submit with good grace. Not only in this country but in America, a grip seems to have been lost of the incandescent business, and in the States they consider there is no more pressing problem.

A few months ago in the correspondence columns of the "GAS JOURNAL" a letter appeared under the title "Is Lighting Worth Keeping?" in which the correspondent hoped the general opinion throughout the country would be in the affirmative; but he ventured to think that the science and practice of illumination had been sadly neglected by gas undertakings as a whole. He instanced the steps taken by his undertaking to meet the situation; and the figures quoted showed that, by properly organized maintenance, very few of the customers of his undertaking had turned to electricity.

Gas salesmen should never forget the fact that from a hygienic point of view gas lighting is superior to electric lighting, and where there is a leaning towards the latter for no other reason than the idea that it is easier manipulated than gas, we should drive home our points on its hygienic value. No. 86, Vol. IX., of "A Thousand and One Uses" will illustrate the ease with which large and small installations can be operated by switches.

It might be well for those who treat the incandescent business lightly to realize that thirty years ago the whole of the output of gas was practically a lighting load, and the mere fact that we have installed ourselves securely in the heating and cooking business should not make us discountenance lighting, which secured us a footing for the more extensive trade. The policy of indifference to the incandescent business is fatal to progress. Our sole revenue years ago was from the sale of gas. It was profitable; and with the auxiliaries of cooking, heating, and industrial appliances, the lighting load has lost none of its importance. Let us keep a grip of this branch of our business, and warn the man who says it can't be done that his rival is not far from the doorstep.

How are we to retain and develop gas lighting? First, by supplying gas of regular quality and pressure; secondly, by getting our consumers to discard their cheap and unreliable burners; and thirdly, by systematic maintenance.

The first, as already referred to, is a condition which every well-managed undertaking should fulfil with or without legislation; but where there has been neglect in the past, the Gas Regulation Act will enforce a regular standard.

The second perhaps brings us most of our complaints. Cheap and unreliable gas-burners have done more to popularize electricity than all the canvassing and propaganda of our competitors; and it is unfortunate that gas undertakings, knowing the havoc these fittings have played, and are still playing, with this side of our business, have not in every case adopted standard fittings to suit their local needs and minimize the evil. Some undertakings (chiefly companies) unfettered in their procedure have adopted standard fittings with good results; but there are many whose policy is restrained by local conditions. If we are to win through, the sooner local arrangements are made to meet the situation, the better it will be for the community and for the industry as a whole. If it is not possible to adopt a standard, every effort should be made by undertakings to influence their consumers to instal fittings of a good type. Let the appeal be direct by circular-letter, and let the best type of fittings be named. Why should we hesitate to name and recommend the efficient article? And at the same time let us follow it up by exhibitions in different parts of the area of supply of the various types of fittings recommended and of the "wrong" articles. Without demonstrations, even a circular-letter may not have much effect.

It is surprising that very little advertising of gas-burners is done on a large scale by manufacturers, whereas we see large and striking advertisements (some of them occupying gable ends of properties) of incandescent mantles. Some of these advertisements would almost lead the public to believe that no matter what type of burner they have, the mantle would turn night into day. Let us advertise our good burners, as effectively and generously as we do our incandescent mantles, with a note of warning to keep a look-out for the "wrong 'uns," and we shall soon reduce our lighting complaints.

The unfortunate matter about the whole business is that with some people it is well-nigh impossible to convince them that the majority of cheap burners are unreliable, and are practically useless for present-day gas, and that merchants, without regard to the consequences to gas undertakings and consumers, stock and sell them. Private enterprise has had a fairly good run to cope with the lighting business; but having failed to justify its freedom from competition from gas undertakings, it is up to each concern to make strenuous efforts to develop this trade.

And, thirdly, as to maintenance. This question was before the North British Association of Gas Managers recently, and the opinion was freely expressed that for satisfactory results, maintenance of all fittings is absolutely essential. The first thing that must be done by us, however, is to interest our consumers as much as possible in their domestic gas affairs, and invite their co-operation in keeping their fittings, whether private or otherwise, in a state of efficiency. How many people ever think of communicating with the gas undertaking that there is something wrong with their gas-fires until they commence to use them in early winter? Consequently there is a rush of complaints which takes the department by storm, and instead of being able to give appliances the complete overhaul or renewal necessary, they are often only temporarily adjusted. It is not to be wondered at that the first recurrence of similar trouble is apt to bring the appliance into disfavour. Systematic seasonal maintenance would remedy this, and besides reducing our complaints of "bad gas" where the service and internal pipes are adequate, would put our incandescent business on a proper footing.

Had general maintenance been adopted years ago, there would have been fewer "change-overs" to electric light. We had, and still have, the remedy in our own hands. Why not apply it now to safeguard our own interests irrespective of adverse criticism? There is no other solution of the problem. It is, therefore, the immediate concern of distribution staffs to see that the question is thoroughly considered in view of the passing of the old and the introduction of the new standard of charge.

The incandescent question is a finer and more difficult problem to solve than the maintenance of cooking and heating appliances. We have several classes of consumers to cater for; and maintenance which will suit domestic will not suit industrial consumers. The latter would require more visits per annum; and while the charge for maintenance of domestic incandescent fittings could be included in the price per thousand or per therm, it might be found necessary in the case of industrial concerns, and halls, churches, &c., to enter into contracts for regular maintenance. This, perhaps, is better realized when we compare for example the maintenance necessary for an engineering establishment with the requirements of a hall or church.

Large-Scale Cooking and Baking.

The subject of large-scale cooking and baking is effectively dealt with in No. 92 of "A Thousand-and-One Uses for Gas." In the first place, there is an article on hotel cooking arrangements in Switzerland, which includes photographs and a plan of the kitchen of the Hôtel des Trois Couronnes at Vevey, wherein are installed twelve gas-heated cooking and boiling appliances. Reference is made by M. Kupfer, the Director of the Hotel, to the possibility when gas apparatus is used of keeping a careful watch on the fuel consumption. He finds that gas can very favourably compete with coal in the matter of cost; and there is general satisfaction with the many improvements resulting from the installation of modern gas-cooking appliances in the kitchen. The second article—by Mr. P. G. G. Moon, the Engineer and General Manager of the Bournemouth Gas and Water Company—describes a very successful three weeks' exhibition of bakery by gas which recently took place in the Company's centrally situated showrooms. A mutual arrangement was made whereby the showrooms were fitted up by the Company as an up-to-date gas bakery, and placed at the disposal of a large firm of confectioners in the town and their bakery staff. The installation included a 4½ B.H.P. gas-engine. A test was made of the amount of gas used for baking and power over a period of fourteen working days. This came out at 21,000 c.ft., or an average of 1500 c.ft. of gas per day. At 4s. 9d. per 1000 c.ft., this is equal to a daily cost of 7s. 1½d.; a week's production being nearly 7000 loaves, gâteaux, and fancy cakes. Other advantages, of course, included saving of time and labour, with ease and cleanliness of manipulation. The facts given should prove suggestive to others.

Among recent wills proved is that of Mr. Robert Hume Ainsworth, who was Manager of the Solihull Gas Company. The gross amount is put at £1981, with net personalty £1796.

The Richmond Gas Stove & Meter Company are to-day officially opening their new offices and extension to their works at Grappenhall, Warrington. The Lord Mayor of Manchester (Alderman W. Kay, J.P.), will perform the opening ceremony, supported by Sir W. Peter Rylands (President of the Federation of British Industries), Mr. H. James Yates, F.C.S. (Chairman of Radiation Ltd.), the Mayor of Warrington (Councillor Robert Henshall, J.P.), and other local gentlemen. This is the completion and concentration of the Richmond Company's new works on one site of twenty acres.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Orders Obtained under Section 1 of the Gas Regulation Act, 1920.

SIR,—In looking through some of the Orders obtained, I am particularly interested in the standard price and relative dividend question, but cannot find any guidance as to the effect the "declared" calorific value will have upon standard price or dividend, if any.

For instance, assuming your standard quality prior to the Gas Regulation Act is 500 B.Th.U. gas, you base your schedule costs upon this quality in the application to the Board of Trade, so as to arrive at your suggested new standard price per therm. After your official inquiry, you must declare the quality of gas you intend to supply. What I would like to be advised upon is, supposing you declare to supply (say) 480 B.Th.U. gas, what effect has this circumstance upon your new standard price in relation to the dividend a sliding-scale company would be allowed to pay—*i.e.*, as the suggested quality you intend to supply is less than your standard in your Private Acts, does your standard price in your new Order reduce *pro ratâ* to quality before you will be allowed to pay your standard dividend, or has the quality of gas you intend to supply any bearing upon dividends?

EXAMPLE.

Standard quality upon which the scheduled costs were prepared	500 B.Th.U.
"Declared" quality you intend to supply .	480 B.Th.U.
New standard price of gas—say	1s. 3d. per therm.
Standard dividend—say	5 p.ct.

What rate of dividend in the above circumstances would you be entitled to pay having regard to the quality of gas supplied—namely, 480 B.Th.U.—being less than the standard in your Private Act?

There appears in some quarters to be an opinion that your standard price, which was based upon a certain quality of gas, would be reduced *pro ratâ* if your quality "declared" is lower than the quality upon which the new standard price was based before you would be permitted to pay your standard rate of dividend. I cannot find either guidance upon the point in the Gas Regulation Act or reference in any of the Orders issued by the Department, and therefore would be extremely obliged if some of your readers would enlighten and guide me in this important matter.

I may incidentally add that personally it is my opinion that the quality of gas supplied does not affect in any way your standard price or dividend, and that whether you supply below or above the quality upon which your standard price was based, the standard price and standard dividend—irrespective of the quality supplied—are always that stated in the Order issued by the Board of Trade, until such times as they have been varied or altered by the issuing of a new Order.

Oct. 15, 1921. ENQUIRER.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Oct. 12.]

Nos. 26,045 to 26,688.

BRIGG, P. R.—"Manufacture of sulphate of ammonia," No. 26,571.

CLARK, F. W.—"Control of secondary-air supply to gas-fired furnaces." No. 26,327.

CLARK, F. W.—"Gas-fired furnaces." No. 26,328.

DENHAM, F. C.—"Gas-saving device for cooking utensils and domestic gas-cookers, &c." No. 26,523.

HUMPHRIES, H. B. P.—"Apparatus for bringing liquid into contact with gases." No. 26,121.

KOPPERS COMPANY.—"Purification of gases." Nos. 26,472-82.

LESSING, R.—"Manufacture of sulphate of ammonia." No. 26,440.

LIVERSEDGE, J. W.—"Mechanical vehicle fitted with devices for crushing, screening, combustion, and conveyance of refuse, and production of heat and power." No. 26,384.

LLOYD, H. G.—"Manufacture of coal, &c., briquettes." No. 26,353.

M'BLAIN, J.—"Combustion of solid, liquid, or gaseous fuels." No. 26,198.

MANKTELOW, E.—"Welding pipes for use with mixed gases." No. 26,420.

MERZ AND M'LELLAN.—"Retorts, gas-producers, &c." No. 26,542.

SMITH, W. F.—"Method of connecting and repairing pipes for conveying liquid, steam, or gas." No. 26,375.

STATTERS, A. W.—"Retorts, gas-producers, &c." No. 26,542.

TRAVERS, M. W.—See Clark, F. W. Nos. 26,327-8.

WEEKS, E. G.—"Retorts, gas-producers, &c." No. 26,542.

WOODWARD, C. H.—"Hot plate for cooking ranges, gas-stoves, &c." No. 26,434.

Gas Lighting of Trains to be Abolished in France.—The Paris correspondent of "The Times" states that a sequel to the Batignolles tunnel disaster has been the issue of a strongly-worded circular-letter by M. Le Trocquer, the Minister of Public Works, to all railway companies, instructing them to take immediate steps to abolish the use of gas in the lighting of trains. Gas lighting must be, he says, abolished on all express trains by Jan. 1, 1923, and on all suburban trains by Jan. 1, 1924. The letter concludes by asserting that the directors of companies will be held personally responsible in the event of accidents in any way attributable to neglect of this admonition.

MISCELLANEOUS NEWS.

GAS REGULATION ACT APPLICATIONS.

The following further notices have appeared in the "London Gazette" of applications by gas undertakings to the Board of Trade for Orders under section 1 of the Gas Regulation Act.

Dover Gas Company.

The maximum price now authorized in respect of the supply of gas by the undertakers is 8s. 3d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 8·97d. per therm.

Langley Mill and Heanor Gas Light and Coke Company, Ltd.

The standard price now authorized in respect of the supply of gas by the undertakers is 4s. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 6d. per therm.

Mynyddislwyn Urban District Council.

The maximum price now authorized in respect of the supply of gas by the undertakers is 5s. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 8·6d. per therm.

Rowley Regis and Blackheath Gas Company.

The maximum price now authorized in respect of the supply of gas by the undertakers is 4s. 6d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 9d. per therm.

Stourport Gas Company.

The standard prices now authorized in respect of the supply of gas by the undertakers are 4s. 6d. and 5s. per 1000 c.ft.; and the prices they have asked the Board of Trade to substitute for this are 1s. 7·2d. and 1s. 8·4d. per therm.

DECLARATIONS OF CALORIFIC POWER.

Burgess Hill and St. John's Common Gas Company.—460 B.Th.U. (Oct. 20.)

Midsomer Norton Gas and Coke Company, Ltd.—500 B.Th.U. (Oct. 7.)

Ryde Gas Light Company.—450 B.Th.U. (Nov. 1.)

MR. MILNE WATSON ON GAS PRICES.

The following reasons given by Mr. Milne Watson, the Governor of the Gas Light and Coke Company, as to why the price of gas has not been reduced, have been published in the newspaper press: Before the war the value of coke, tar, benzole, sulphate of ammonia, pitch, and creosote was about 82 p.ct. of the cost of the coal. During the war, this figure fell to about 66 p.ct.; and now the value is only 57 p.ct. The cost of coal has increased; the returns from the residuals have decreased. To this the man in the street will reply that the cost of coal has now been reduced. But a large gas company have no immediate gain thereby, because they have in hand large stocks bought before the price fell. In addition to this, the coal stoppage cost this Company an extra £500,000. Then there is an increase of 475 p.ct. in the cost of gas oil, and 170 p.ct. in freights. What can the gas companies do? If we reduce the present price of gas, we shall never make up what we have lost by the war and the coal stoppage. Dividends now work on a sliding-scale principle. The higher the price of gas, the lower fall the dividends of gas shareholders.

SULPHATE OF AMMONIA AMENDED PRICES

For October, November, and December Deliveries.

In a circular signed by the Chairman (Mr. D. Milne Watson), the British Sulphate of Ammonia Federation, Ltd., announce that, until further notice, the following prices will be charged for sulphate of ammonia for October/December, subject to supplies being available. Prices for January and later months will be announced later.

The new prices for October/December cancel those reported in the "JOURNAL" of the 5th inst., and are as follows:

For October/November Delivery—

£15 8s. per ton for neutral quality, in fine friable condition, free from lumps, containing 25¾ p.ct. ammonia, or

£14 5s. per ton for ordinary quality, containing 25¾ p.ct. ammonia.

For December Delivery—

£15 13s. per ton for neutral quality, as above described.

£14 10s. per ton for ordinary quality, " "

All other terms and conditions as before, except that the allowance for taking delivery *ex* works by road vehicle is raised to 10s. per ton for November and December delivery.

CHARGE FOR GAS AT NEWCASTLE.

Interviewed by a local "Chronicle" representative, with regard to the price of gas, Mr. T. P. Ridley, the Secretary of the Newcastle and Gateshead Gas Company, said the charge immediately before the war was 2s. 1d. per 1000 c.ft., less discount. Up to May of this year it had never been above 3s. 4d.; while from July to December of last year it was only 2s. 6d. The charge at present is 1s. 2d. per therm, which is the equivalent of 5s. 6¼d. per 1000 c.ft., less discount; but the change

in the method of charging is not responsible for the higher accounts. The price to-day would have been 5s. 6½d. per 1000 c.ft. if there had not been any change of method. The low price which has been charged in the past has been due to the high prices obtained for residual products exported. If these prices had not been obtained from foreign buyers, the price of gas during nearly the whole of the war period would have been considerably higher than it was. For some years now local gas consumers have had their gas at a low price at the expense of the foreigner. These markets having collapsed after the coal strike in the autumn of last year, the charge for gas has had to be raised to meet the full costs of manufacture and distribution. The price should have been increased to the present charge in January last; but this was impossible owing to 3s. 4d. being the maximum charge then allowed under old Acts of Parliament. In April, however, a Board of Trade Order authorizing higher charges, and compelling the Company to charge by therms, was obtained after a full hearing of the representations of the local Corporations and Councils. But between January and the obtaining of the Order at the end of April, the Company supplied gas at a serious loss; and, in addition, the miners' dispute of April to June resulted in a further loss of over £50,000. The Newcastle Company have not increased their price since the dispute ended: but, in view of the losses referred to, they cannot reduce it immediately a reduction in the cost of coals and wages takes place.

Consumers must remember that a fall in the day-to-day price of coals does not necessarily mean an immediate decline in the cost of producing gas, as time is required for the full effect to be felt. In the same way, it may be pointed out, a rise in the price of coals is not immediately felt in the price of gas. Further, before the miners' dispute the consumption of gas showed an increase of 5 p.ct. on the corresponding period of last year. Since the determination of the dispute, there has been a decrease of over 15 p.ct. This has a serious effect, as the lower the consumption, the higher the standing costs per therm, and consequently the more difficult it is to make reductions in price. The last dividend paid was at the rate of 3 p.ct. per annum, which makes it clear that not much of the 1s. 2d. per therm goes into shareholders' pockets, and that there can be no question of profiteering.

HISTORY OF THE BLACKBURN GAS UNDERTAKING.

Mr. G. P. Mitchell, the Blackburn Gas Engineer, makes interesting reference to the local gas undertaking in the Official Handbook of the Chamber of Trade.

He mentions that the works were purchased from the Blackburn Gas Light Company in 1878. There were then two works—Jubilee Street and Addison Street—and the annual output of gas at that time was about 315 million c.ft. In 1900 the new works at Greenbank were completed; and the Jubilee Street works were closed. Since that time the consumption of gas in the Corporation's area of supply has increased by leaps and bounds. In 1910 the output was 741 million c.ft., and last year it was over 843 million c.ft. There are over 36,000 consumers on the department's books; while a recent census of the number and types of heating and cooking appliances revealed the fact that no less than 37,033 of these useful labour-saving articles were in use. Altogether, over 60,000 tons of coal are carbonized annually.

Of recent years the capacity of the plant has been taxed to the utmost; but gradually it has been renewed and enlarged. A large installation of vertical retorts, designed on the latest principle, is nearing completion at Greenbank, and will be of great assistance in meeting the demands during the coming winter. The gas-mains total to over 132 miles, varying in size from 24 in. down to 2 in. diameter. Considerable enlargements have taken place recently, and are in hand, with a view to improving the supply and increasing the output.

VERTICAL RETORTS AT DUNFERMLINE.

The Gas Manager's Annual Report.

A report is to hand by Mr. James Campbell, the Engineer and Manager of the Dunfermline Corporation Gas-Works, as to the results of his department for the year ended May 15 last.

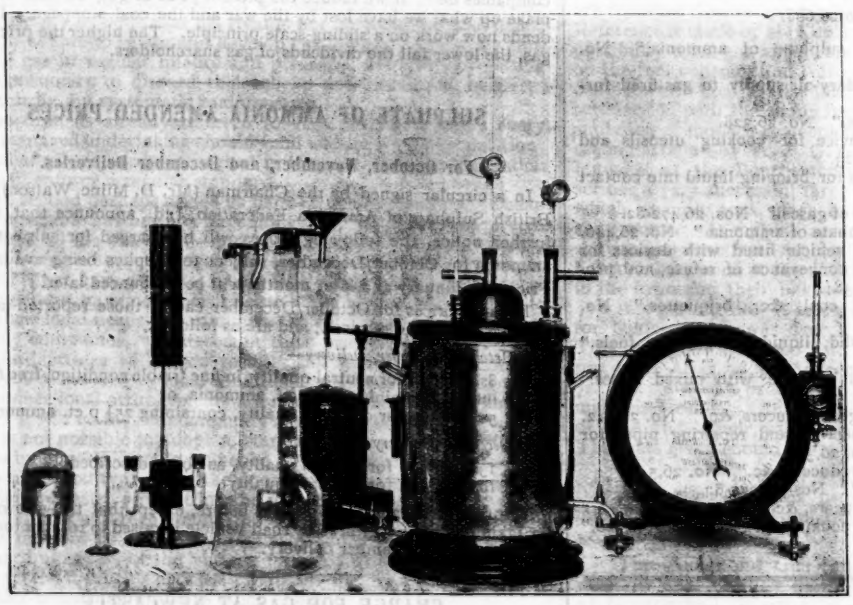
The expenditure on revenue account amounted to £67,965, an increase of £12,875, and the income to £83,100, an increase of £9096, compared with the previous year. The result is a gross profit of £15,135, and a net profit (after placing £500 towards a retort repair fund) of £258, to which has to be added £498 brought from the previous year, making a total credit balance of £756.

During the year, 19,408 tons of coal were carbonized, the cost of which was £37,286, equal to an average of 38s. 5d. per ton. The prices paid for coal during the last eleven years were, per ton: 8s. 5d., 8s. 8d., 12s. 2d., 12s. 11d., 11s. 10d., 18s., 16s. 8d., 19s. 6d., 23s. 7d., 27s. 10½d., 38s. 5d. It will be noted that the price of coal last year was 30s. per ton more than in 1911, an increase of 356 p.ct.; while the price of gas was only increased from 2s. 3d. to 3s. 8d. per 1000 c.ft., an increase of 63 p.ct. Coal was advanced in price by 4s. 2d. per ton as from May 12, 1920; and this advance has been in force during the whole year. Railway rates on coal were advanced by 11d. per ton as from Sept. 1, 1920.

During the miners' strike, lasting from Oct. 16 to Nov. 3, 1920, the coal used from stock proved to be of poor quality, necessitating the use of larger quantities than usual. The coal store had been filled with about 1400 tons during the summer; but the whole of this quantity, with the exception of 100 tons, was lifted during the strike. From November to the middle of January, it was impossible to add to this small stock, and during the period of heaviest consumption of gas the stock of coal never exceeded this amount, which was only equal to 1½ days' requirements. Supplies became more plentiful in January,

BOYS CALORIMETER.

Gas Referees Latest Pattern.



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and from then until the last week in March the stock was added to until it was 1400 tons; but on April 1 the second miners' strike within a year occurred, causing the whole of this quantity to be again lifted from stock. During the latter period, considerable quantities of coal, including coal from America, had to be purchased at high prices to maintain the gas supply; and all these circumstances seriously added to the cost of coal during the year.

The total quantity of gas made during the year amounted to 252,336,000 c.ft., an increase of 7,780,000 c.ft., equal to 3·14 p.ct.; while the amount of coal used showed a decrease of 3358 tons compared with the previous year.

The average yield of gas per ton of coal over the year amounted to 13,001 c.ft., compared with 10,742 c.ft. last year—the increase being due to the installation of vertical retorts brought into use last August. The yield of gas during the period of working these vertical retorts was 14,237 c.ft. per ton of coal.

The following statement shows the amount of gas made, coals carbonized, and yield of gas per ton, during past years:

Year ending	Gas Made.	Tons of Coal Carbonized.	Gas Made per Ton of Coal.
May, 1911	140,113,000	16,251	8,621 c.ft.
1912	145,367,000	16,421	8,852 ,,
1913	156,961,000	17,496	8,971 ,,
1914	166,008,000	19,065	8,707 ,,
1915	184,411,000	20,249	9,107 ,,
1916	176,268,000	20,672	8,526 ,,
1917	166,961,000	19,733	8,461 ,,
1918	205,232,000	19,900	10,313 ,,
1919	218,700,000	22,514	9,714 ,,
1920	244,566,000	22,766	10,742 ,,
1921	252,336,000	19,408	13,001 ,,

Less coals were used last year than in 1917, although the gas made increased by over 85 million c.ft.

The total wages paid in the works during the year amounted to £14,059, equal to 13·37d. per 1000 c.ft. of gas made. The following are corresponding figures for previous years:

Year.	Total Wages.	Cost per 1000 C.Ft.
May—1914	£5,588	8·4
1920	£14,846	14·57
1921	£14,059	13·37

Wages were increased by national agreement on May 1, 1920, and again on Jan. 1, 1921.

The net income from residuals amounted to £27,152, compared with £22,230 last year, being an increase of £4922. This return from residuals is equal to 27s. 11·74d. per ton of coal, or 72·82 p.ct. of the cost of the coal, making the net price of coal 10s. 5·35d. per ton. During the greater part of the year under review, residuals sold at high prices; but towards the end of the year prices collapsed. For coke, 55s. per ton was obtained at one time; but this fell to as low as 35s. In June, 1920, 50s. per 100 gallons of tar was received; but by December this price had risen to 71s. 2½d. But a fall set in afterwards; and by May the price was back to 26s. 8d. Sulphate of ammonia was in demand at good figures until December, when the price for home sales was reduced—the reduction dating back to August. At the same time the shipping demand fell off, and the price for shipment was reduced to considerably below that for home delivery. The price has now fallen to such an extent that it is unprofitable to make sulphate; and at present the plant is shut-down.

Dealing with the new vertical retort plant, Mr. Campbell remarks: The new settings of the Woodall-Duckham vertical retorts were brought into use on Aug. 23, 1920, and the same day all the old plant was shut-down. This new plant has given the utmost satisfaction; and the results obtained are considerably above the contractor's guarantee. It is, of course, unfortunate that the first year's experience with the new plant should have included times of unparalleled difficulty with regard to coal; and but for this the result would have been better. As it is, with an increased make of 7,780,000 c.ft., there was a saving of 3358 tons of coal, and a decrease (notwithstanding increases of wages on two occasions) of £2619 in carbonizing wages compared with the previous year, and this for only nine months' working. It is certain that, but for this plant, it would have been a very costly matter to maintain the gas supply to the city during the last coal strike, as the old plant would have required at least 40 p.ct. more coal.

TRADE NOTES.

[For "Journal" Advertisers.]

"Ironclad" Mantles.

There is to hand from Messrs. Curtis's and Harvey, Ltd., of Cannon Street House, E.C., a copy of a handsome new catalogue entitled "Incandescence," which deals with the firm's well-known "Ironclad" and other British made incandescent gas-mantles. Mantles for every system of lighting are shown. Printed on art paper, and in several colours, the catalogue is of the loose-leaf style, so that fresh pages can be added when necessary. Messrs. Curtis's and Harvey are to be complimented on the get-up of the booklet, which will certainly serve, as we have no doubt it is intended to do, as a permanent advertisement of the quality of the mantles with which it deals.

The Late Mr. Balfour Browne.—In memory of the late Mr. J. H. Balfour Browne, K.C, LL.D., a Master of the Bench of the Middle Temple, a Memorial service was held yesterday week at the Temple Church. Among others in the congregation were Mr. W. J. Jeeves, Mr. Honoratus Lloyd, Mr. E. H. Tindal Atkinson, Mr. F. N. Keen, and Mr. Arthur L. Griffith (representing the Society of British Gas Industries).

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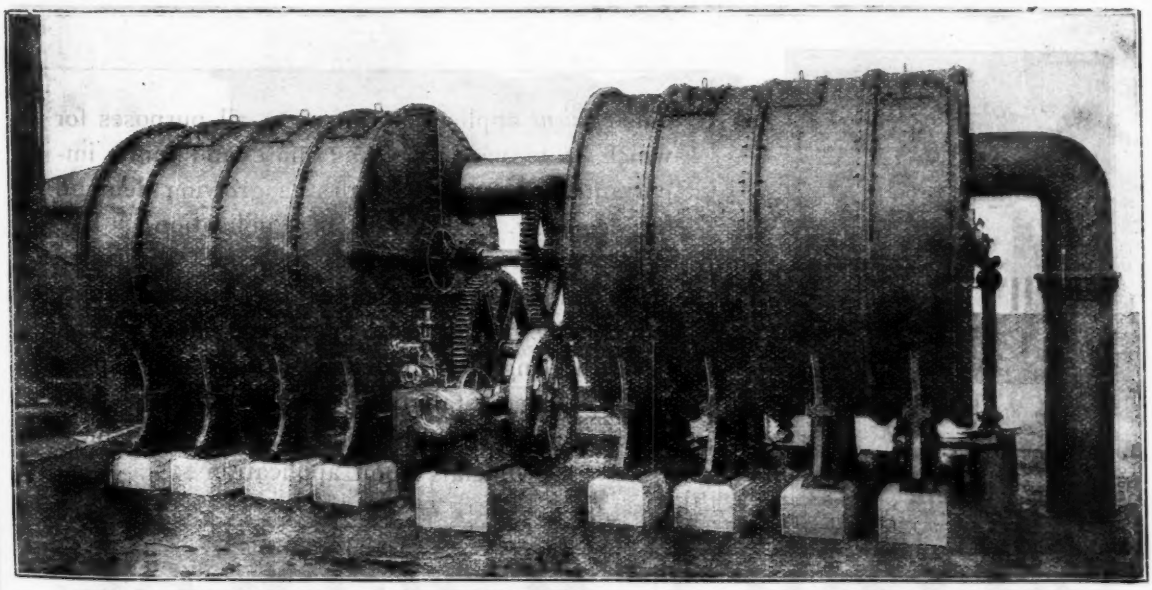

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CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

London, *Oct.* 17.

Business in the London tar products market continues quiet. There is not much real inquiry for pitch, and the price of 60s. to 62s. 6d. per ton, last recorded, remains without alteration. Creosote is a steady market at about 8d. to 8½d. per gallon. Tar spirits are scarce and firm at 3s. 3d. to 3s. 6d. per gallon for pure benzole and pure toluole, and about 3s. per gallon for 95/160 solvent naphtha. Pyridine bases is not in particular request; the price being nominal at 5s. 9d. per gallon into buyers' drums.

Sulphate of ammonia is in good demand, and the production is readily absorbed.

Tar Products in the Provinces.

Oct. 17.

The average values for gas-works products during last week were: Gas-works coal tar, 50s. to 54s. Pitch, East Coast, 60s. to 65s.; West Coast—Manchester, 55s. to 57s. 6d.; Liverpool, 55s. to 57s. 6d.; Clyde, 55s. to 57s. 6d. Benzole 90 p.ct. North, 2s. 4d. to 2s. 6d.; crude 65 p.ct. at 120° C., 1s. 11d. to 2s. naked at makers' works; 50-90 p.ct., naked, North, 2s. 3d. to 2s. 4d. Toluole, naked, North, 3s. to 3s. 1½d. nominal. Coal tar crude naphtha in bulk, North, 11d. to 11½d. Solvent naphtha, naked, North, 2s. 8d. to 2s. 9d. Heavy naphtha, North, 2s. 7d. to 2s. 9d. Creosote, in bulk, North, liquid, 8d. to 8½d.; salty, 7¾d. to 8¼d. Heavy oils, in bulk, North, 10½d. to 11½d. Carbolic acid, 60 p.ct., 1s. 6d. Naphthalene, £20 to £30; salts, £7 to £9, bags included. Anthracene, "A" quality, 8d. to 10d. per minimum 40 p.ct.; "B" quality, nominal.

FROM A MARKET CORRESPONDENT.

The bye-products market remains very disturbed, but without any material changes in the quotations. There is very little business passing in pitch; and this market can be described as weak; prices having been quoted down to between 55s. and 60s. per ton. Briquette manufacturers in South Wales have still a good quantity of pitch, and are naturally holding off the market at the moment. Their position is somewhat difficult, because of the general fall in fuel values. Carbolic acid remains a restricted trade since current quotations do not encourage the production of crystals or even crude acid. The latter is still quoted nominally at 1s. 6d. per gallon; while crystals are in the neighbourhood of 6d. per lb. If there is a best section, it is found in solvent naphtha, in which the rubber industry has been taking more interest of late. The latest value is in the neighbourhood of 3s. per gallon. Naphthalenes remain very quiet, and the firelighter industry is not coming into the market for crudes as is usually the case at this time of the year. Common qualities of crude are available at £5 10s. per ton. Refined naphthalene still makes £16 to £18 per ton. Cresylic acid is 2s. 3d. per gallon for pale quality and 2s. per gallon for dark quality. There is a better supply of 90 p.ct. benzole; but the price is maintained in the neighbourhood of 3s. per gallon. Creosote is fairly steady at 8¼d. per gallon; but probably it is only maintained at this price because of the low production. The volume of trade passing in intermediate products continues to grow slowly. Stocks are getting to very low levels, and an upward tendency in several lines would appear to be due, especially as exporting inquiries are now coming forward in fair bulk. Consumers of aniline oil and salt are inclined to hold off the market; but prices are still maintained at 1s. 7d. and 1s. 8d. per lb. respectively. Resorcin has been rather more inquired for at 5s. 6d. per lb. for technical grade. Salicylic acid still meets small demand at recent values. Beta naphthol remains at 2s. 6d., and anthracene 40 to 50 p.ct. at 9d. per unit.

Sulphate of Ammonia.

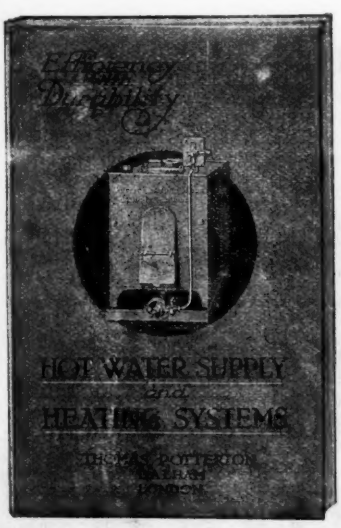
The home demand for sulphate is rather poor at the moment, probably following on the recent increase in prices for November and December deliveries. Export business, however, has improved. Production is still limited, and prices have an upward tendency. It is announced that an agreement has been reached with reference to the disposal of the stocks of nitrate in Europe and also in Chile; but it is very doubtful whether the recently reduced prices for this article will affect the market in sulphate of ammonia to any material extent.

Price of the Bothwell and Uddingston Gas-Works.—The purchase price paid by the County Council of Lanark for the Bothwell and Uddingston Gas-Works is £210,000. It is proposed to increase the gas rate by 10d. per 1000 c.ft.

St. Anne's Gas-Works Purchase.—The price to be paid to the St. Anne's-on-the-Sea Gas Company for their undertaking is £69,600. To this will be added £11,000 extra capital, making the total cost to the proposed borough of Lytham and St. Anne's £80,600.

Cheap Gas at Bangor (co. Down).—The Bangor (co. Down) Urban Council have agreed, on the motion of Mr. Fegan (the Chairman of the Gas Committee), to reduce the price of gas, as from Oct. 1, from 6s. 3d. to 5s. per 1000 c.ft.—the existing rates of discount to remain in force. Mr. Fegan explained that the discount to ordinary consumers would bring the price down to 4s. 8d.; while in the case of large consumers, who have a special discount, the price would be 4s. 6d. It was, he said, a matter of pride that the price of gas in Bangor should be very considerably less than in any town or city in Ireland, with the exception of Belfast; and it was due to the Manager (Mr. Barker Mitchell), and his staff, to say that it was only because of the very efficient manner in which the undertakings were being conducted by them that gas could be supplied so cheaply. It was not true, as had been stated in some quarters, that the quality of the gas had been reduced, and that the works were being "starved."

WATER HEATING



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Glover-West Vertical Retorts.

In the form of a handsome book, there has been published by West's Gas Improvement Company, Ltd., of Miles Platting, Manchester, an account of work done during and since the war in connection with the Glover-West system of continuous carbonization in vertical retorts. The record is one in which the firm may fairly take pride. Reference is made to the researches during the war period which established the practicability of generating water gas by the introduction of steam during the process of continuous carbonization in vertical retorts; and it is remarked that, though the Glover-West system in its pre-war form provided the essentials for successful steaming, it was soon apparent that the design could readily be modified to give results far in excess of these. The devising of such modifications after the war had, however, to be carried out concurrently with the more urgent duty of supplying carbonizing plant quickly to undertakings in pressing need of it. The modifications in design, therefore, to place the new possibilities within the reach of the industry had to be worked-in gradually; and the assurance is given that the end is as yet by no means attained of the developments of continuous carbonization by which still greater yields of gas and residuals will be obtained. The contracts illustrated and briefly described relate to installations in various parts of the world. The final section of the book indicates some of the special features of the Glover-West system. The increased demand for Glover-West installations to which the book testifies has, we are told, been vigorously met by large additions to plant and machinery; and advantage has been taken of the lessons of the war to organize production on the most up-to-date lines.

Peterborough Gas Supply.—It is stated that the Peterborough Town Council, having for two years continuously received complaints regarding the city's gas supply, and the desired improvement not being forthcoming, decided last week to ask for a Board of Trade inquiry into the matter.

Price of Gas at Accrington.—At a meeting of the Accrington and District Gas Board last week, Mr. A. J. Harrison said there had been a misunderstanding regarding increases in the cost of gas. The actual advance to the ordinary consumer was only 2d. The advance was to large consumers and local authorities, who only needed gas five months of the year, and for whom special plant was kept idle during the other part of the year. For the last two years they had a balance on the right side; but this year they had not been able to show such a satisfactory return, owing to the coal trouble. The present rates were lower, on the average, than those of undertakings of similar size in the country. He knew of no essential public commodity advancing so little as gas when the cost of raw material and the increased rate of wages were considered. Coal and wages had advanced three times; but only 75 p.ct. had been added to the price of gas.

A Workman's Compensation Act Claim.

A man named William H. Salter was an applicant in a Workman's Compensation Act claim in the Bow County Court, before Judge Graham, K.C.; the respondents being the Gas Light and Coke Company. On March 14, 1920, applicant was painting at the respondent's works, when the scaffolding collapsed, and he fell, injuring his hip, he alleged. He was away for some time, being paid 35s. a week, as full compensation for total incapacity; and when he went back he was put to light work, until he found this too much for him. In the end he was dismissed; and he now claimed that, as he was unable to follow his occupation as a painter, and there was no suitable light work, he was "an odd lot in the market." Applicant said that thirty years ago he met with an accident when on the railway, and injured his leg and hip; but the injury was not a lasting one. His work had never been interfered with, as he had always climbed high ladders to do painting, until the last accident. After his discharge he got a little work from the East Ham Council; and then, on applying to the Guardians for relief, he was offered a job as day watchman at £3 16s. 4d. per week, which he was now doing. But this was against the 2s. 3d. an hour he would have received as a trade union painter. Dr. Murray said that, in his opinion, applicant had tubercular hip disease, which had remained quiescent until this last accident. Sir George Hastings, M.D., said he could find no trace of a fresh injury. Counsel agreed to make no speeches, but to leave the case to the Medical Referee. In five seconds Judge Graham said it had been decided that the applicant must fail; and judgment was entered for the respondents, with costs.

Dudley Gas Company.—On behalf of the Town of Dudley Gas Light Company, Messrs. A. & W. Richards offer for subscription at par £32,880 of 7 p.ct. redeemable stock. The Company have paid maximum dividends on their ordinary shares for the past forty years.

Coke Distribution at Barrow.—At the Barrow Town Council meeting on Monday of last week, Alderman A. Brown (the Chairman of the Gas and Water Committee) said the unemployed had requested the sale of coke at 6d. per cwt. The Committee had decided not to reduce the price; but following precedent on a former occasion when there was distress through unemployment, they had agreed to give 100 tons of coke to the Mayor free for distribution to deserving cases. This was approved by the Council.

Bradford Gas Committee's Appreciation.—The Bradford Corporation Gas Committee have placed on record their warm appreciation of the foresight and good management displayed by the Chairman (Mr. George Walker) and Deputy-Chairman of the Committee (Mr. Fred Wilkinson) and by the Gas Engineer and Manager (Mr. Charles Wood), prior to and during the period of the recent coal dispute—qualities which enabled the gas supply in the city, both for lighting and industry, to be maintained without the public being in the slightest inconvenienced.

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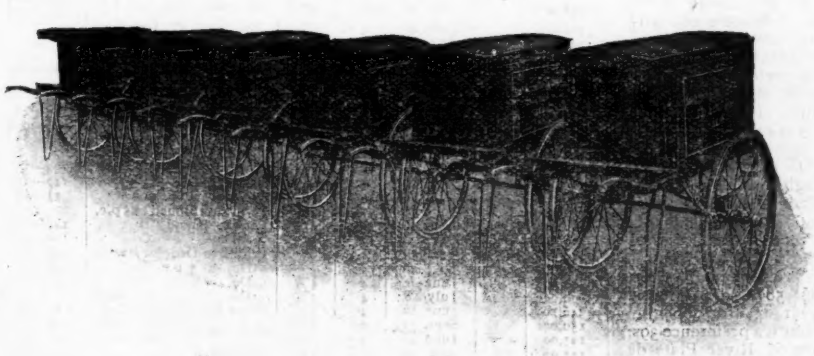

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Gas Strip Reduced.—It was reported at a meeting of the Birmingham Iron Exchange last Thursday that the price of gas (iron) strip for tubes would be reduced £2 10s. as from Monday of this week. The new rate is £15 per ton; and forward business was done on this basis. Owing to the much lower price of steel strip, tubes of this material are being produced in greater quantities than iron.

Proposed Gas-Works Purchase at Hyde.—The Hyde Corporation have appointed a Sub-Committee to consider and report upon the purchase of the Hyde Gas Company's undertaking. The Sub-Committee have interviewed representatives of the Bredbury and Romiley Urban District Council on the matter; and the Town Clerk of Hyde has been instructed to report upon the procedure to be adopted, and the experience of other towns in connection with the purchase of gas undertakings, and to ask the Bredbury and Romiley Council to agree to co-operate with Hyde in regard to the acquisition of the Hyde Gas-Works upon the basis of rateable value.

Reduced Price at Cardiff.—The Cardiff Gas Company announce a reduction in the price of gas throughout their district, commencing from the last quarter-day reading of the meters. New prices will be fixed in each district to correspond with the general reduction. In Cardiff and Penarth, for example, the new price will be 1s. 1·6d. per therm. The reduction is equivalent to about 3d. per 1000 c.ft. Prepayment consumers will participate.

Centralizing Manufacture at Sowerby Bridge.—At Sowerby Bridge, last Thursday, an inquiry was held on behalf of the Ministry of Health with regard to an application by the Council for permission to borrow £5900 to enable them to put down a new gas-engine and compressor, and also to lay a high-pressure main from the gas-works at Sowerby Bridge to those at Luddendenfoot. The Sowerby Bridge Council have decided to cease making gas at Luddendenfoot, and to centralize the manufacture at Sowerby Bridge. There was no opposition to the project.

STOCK MARKET REPORT.

THERE was no improvement last week in the state of things on the Stock Exchange, but rather the reverse. The prevailing tone of markets was as dull; while the measure of quietude was augmented by the Jewish holidays, which kept many members away.

The gilt-edged market, however, again showed out favourably by comparison. Home Government issues even made moderate advances, Friday's figures for the big four being: Consols 48⅝-49 1/16, War Loan 89⅝-89⅞, Funding 72¼-72½, Victory 77-77½. Bonds were in demand; but the new Colonial issues gave way. Railways in general were dull—Home, Colonial, and Argentine.

The Foreign Market showed weakness pretty well all round.

The Miscellaneous Market was persistently dull; foreign sales being a potent depressing factor.

Business in the Gas Market was much quieter, and would have been almost infinitesimal but for the dealings in Gas Light and Imperial Continental. However, the general tone was very good, and some issues made extraordinary advances. The London Companies were firm and unchanged. The Suburban and Provincial group was the most favoured; the gains in quotations being: Hornsey 17, Alliance and Dublin 4, Ilford "A" and "C" 2, Brentford "A," Lea Bridge, South Suburban, and Newcastle 1 each. Imperial Continental paused in its sharp advance, and the highest price touched was 142, some further light upon the expectations from Germany being desirable. Primitiva prices were not quite up to the level of the week before.

Bargains done for cash during the week were as follows: On Monday, Bombay 3, 3 1/16, Gas Light ordinary 58½, 58⅝, 58⅞, 59, 59¼, 59⅜, ditto maximum 44⅜, 44⅝, ditto debenture 51, 51⅛, Imperial Continental 138, 138½, 140, 140¼, 140½, 142, Primitiva 13s. 9d., South Metropolitan 68⅝, ditto 6½ p.ct. debenture 101-101½. On Tuesday, British 21⅛, Gas Light ordinary 58½, 59⅜, Imperial Continental 139, 140, 140½, 141, Primitiva 14s., ditto preference 37s. 6d., 38s., 38s. 6d., 40s., South Metropolitan 68⅝, ditto 6½ p.ct. debenture 101-101⅝, South Suburban 68¼, Danish 5 p.ct. preference £6 2s., Malta and Mediterranean 7 p.ct. first preference 50s., 51s. 3d. On Wednesday, Continental Union 18, Gas Light ordinary 58⅝, 59¼, 59⅜, 59½, Imperial Continental 139, 139½, 140½, 141, Primitiva 13s., 13s. 6d., 14s. 6d., 14s. 9d., South Metropolitan 6½ p.ct. debenture 100½-100⅝. On Thursday, Alliance and Dublin 50½, British 22 1/16, Commercial 4 p.ct. 55, Gas Light ordinary 58½, 58⅝, 58⅞, 59¼. Imperial Continental 139, 139½, 140, 140½, ditto debenture 81½, 82, Newcastle 59, Primitiva preference 39s., 39s. 6d., ditto debenture 66, River Plate debenture 43¼, Wandsworth Epsom 56½, South Metropolitan 6½ p.ct. debenture 101¼, Folkestone 42, Colonial Gas Association 9s. 9d. On Friday, Alliance and Dublin 50⅝, Bombay 3, 3⅛, Bournemouth "B" 9, 9 1/16, Brentford "A" 69, 70, Bristol 70, 71, European £6 19s. 6d., £7, Gas Light ordinary 58¼, 59, ditto preference 61, Imperial Continental 139, 139½, 140½, ditto debenture 81½, 82, 82½, 82⅝, Primitiva 14s. 9d., ditto preference 39s. 9d., 40s., South Metropolitan 68, ditto debenture 49½, 50, ditto 6½ p.ct. debenture 101-101½, South Suburban 69, 69½, Barnet District "A" 112½, 113, Colonial Gas Association 10s., ditto 7 p.ct. preference 14s. 6d., 15s.

In the Money Market, there was no change from the easy condition which marked the close of the previous week, supplies being ample to meet all requirements. Discount terms were similarly circumstanced. Silver rose to 42⅞d., but fell back before the close. The Bank rate is 5½ p.ct., as fixed on July 12.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issues.	Share.	When ex-Dividend.	Ante-War Dividend & Bonus.	Last Dividend.	NAME.	Closing Prices, July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.c.					
182,049	Stk.	Aug. 26	4	4%	Aldershot 4 p.c. Pref. .	...	50—55	...
1,551,868	,,	Oct. 13	2½	3 1/16%	Alliance & Dublin Ord.	59—64	48—51*	...
374,000	,,	July 14	4	4%	Do. 4 p.c. Deb.	76—79	46—51	...
280,000	5	Aug. 11	7½	4/-	Bombay, Ltd. . . .	5½—6½	3—3½	3—3½
100,000	5	,,	16	4/7½	Bournemouth Gas and Water { 5 p.c. . .	...	7½—8½	...
					{ B 7 p.c. .	15—15½	8½—9½	9—9 1/16
383,110	10	,,	7	7/-	{ Pref. 6 p.c. .	13½—14	7½—8½	...
115,000	10	,,	6	6/-	{ 4 p.c. Deb. .	...	54—59	...
162,065	—	June 30	—	4%	Brentford A Consolid. .	261—266	68—71	69—70
992,045	Stk.	July 15	14	56/-	Do. B New . .	204—209	62—65	...
734,920	,,	,,	11	55/-	Do. 5 p.c. Pref. .	109—111	68—72	...
55,000	,,	,,	5	5%	Do. 4 p.c. Deb. .	91—93	57—59	...
221,400	,,	June 15	4	4%	Brighton & Hove Orig. .	208—213	110—115	...
214,775	,,	Aug. 26	11	10½%	Do. A Ord. Stk.	154—159	77—82	...
344,200	,,	,,	8	7½%	Bristol 5 p.c. max. . .	...	...	70—71
1,287,500	Stk.	July 28	5	5%	British	44—45	21—23	21½—22 1/16
530,000	20	Sept. 29	12½	10%	Do. 4 p.c. Deb. Stk.	88—90	55—58	...
120,000	Stk.	June 30	4	4%	Buenos Aires 4 p.c. Deb.	85—87	42—45	...
245,771	,,	,,	4	4%	Cape Town & Dis., Ltd.	1½—2½	6½—7½	...
100,000	10	May 27	—	6%	Do. 4½ p.c. Pref. .	4—6	4½—5½	...
100,000	10	Apl. 28	—	4½%	Do. 4½ p.c. Deb. Stk.	70—75	53—58	...
100,000	Stk.	June 30	4½	4½%	Chester 5 p.c. Ord. . .	108—110	...	...
157,150	,,	Feb. 26	5	5%	Commercial 4 p.c. Stk.	106—108	54—57	55
1,513,280	,,	July 28	5/9/4	42/8	Do. 3½ p.c. do.	103—105	52—55	...
360,000	,,	,,	5½	38/4	Do. 3 p.c. Deb. Stk.	69½—71½	44—47	...
475,000	,,	June 15	5	5%	Continental Union Ltd.	76—79	18—20	18
100,000	,,	Dec. 11	4	—	Do. 7 p.c. Pref.	115—118	30—31	...
100,000	,,	,,	7	—	Croydon A 10 p.c. . .	...	150—155	...
51,600	,,	Aug. 26	13	13%	Croydon B and C 7 p.c. .	...	120—125	...
178,400	—	,,	12	12%	Derby Con. Stk. . .	123—125	...	...
492,270	Stk.	—	6	4½%	Do. Deb. Stk. . .	102—104	...	...
55,000	,,	,,	4	4%	European, Ltd. . . .	17½—18	6½—7½	6/19/6—7
1,002,180	10	Jan. 29	10	5/0	Gas Light and Coke { 4 p.c. Ord. . .	98—102	58—60	58½—59½
16,298,975	Stk.	Aug. 11	4/17/4	46/8	{ 3½ p.c. max.	76—79	44—46	44½—44½
2,600,000	,,	,,	3½	35/-	{ 4 p.c. Con. Pref.	96—99	58—60	61
4,062,235	,,	,,	4	4%	{ 3 p.c. Con. Deb.	72½—74½	50—52	51—51½
4,674,850	,,	June 15	5	5%	{ 10 p.c. Bonds. .	...	...	...
130,000	,,	Dec. 11	10	10%	Hastings & St. L. 5 p.c.	...	48—50	...
82,500	,,	Sept. 14	5	3½%	Do. 3½ p.c.	87—89	34—36	...
258,740	,,	,,	3½	2½%	Hongkong & China, Ltd.	16½—16½	5—6	...
70,000	10	May 12	11	5%	Hornsey 7 p.c. . . .	...	95—100	...
86,600	Stk.	Aug. 26	9	9%	Ilford A and C . . .	151—154	80—82	...
131,000	,,	July 28	7½	7½%	Do. B	115—118	57—59	...
65,780	,,	,,	6½	5½%	Do. 4 p.c. Deb. . .	92—94	54—56	...
63,500	,,	June 30	4	4%	Imperial Continental .	130—140	138—143	138—142
1,976,000	,,	May 27	9	5%	Do. 5½ p.c. Deb. Red.	84—86	80—82	81½—82½
1,235,000	,,	Aug. 11	3½	3½%	Lea Bridge Ord. 5 p.c. .	119—121	69—71	...
235,242	,,	Mar. 30	6½	3½%	Liverpool 5 p.c. Ord. { A.	211—213	...	...
2,498,905	,,	Feb. 26	10	57/6	{ B.	146—148	...	...
306,083	,,	June 26	4	4%	Do. 4 p.c. Pr. Deb. Stk.	...	...	...
165,736	,,	Aug. 11	7/5/6	6%	Maidstone 5 p.c. . .	...	54—56	...
63,480	,,	Dec. 30	—	5%	Do. 5 p.c. Deb. .	...	40—43	...
75,000	5	June 11	6	5%	Malta & Mediterranean	4½—4½	1½—2½	...
250,000	100	Oct. 3	4½	4½%	Met. of Melbourne { 4½ p.c. Deb.	99—101	88—96	...
341,920	Stk.	May 27	4	6%	Monte Video, Ltd. . .	11½—12	58—60	...
1,475,892	,,	July 28	4½	3%	Newcastle & Gatsh'd Con.	98½—99½	58—60	59
529,705	,,	June 30	3½	3½%	Do. 3½ p.c. Deb.	82—85	48½—50½	...
15,000	10	Aug. 26	—	7/6	North Middlesex 10 p.c.	...	12½—13½	...
53,940	10	,,	7/14/0	5/3	,, ,, 7 p.c.	14—15	7½—8	...
500,000	Stk.	May 12	8	8%	Oriental, Ltd. . . .	117—122	88—93	...
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd. . . .	7½—7½	2—3	...
188,120	Stk.	June 30	—	3½%	Plym'th & Stonesh'se 5 p.c.	...	64—67	...
60,000	50	Aug. 26	15	60/-	Portsea Island, B . .	128—131	64—67	...
100,000	50	,,	12	55/-	Do. C . .	113—121	51—54	...
249,980	5	April 29	8	—	Primitiva Ord. . . .	5½—6	13/16—15/16	13/—14/9
499,960	5	June 26	5	—	Do. 5 p.c. Pref. .	4½—5	1½—2½	37/6—40/-
521,600	100	June 1	4	4%	Do. 4 p.c. Deb. .	91—95	65—67	66
600,000	Stk.	July 28	4	4%	Do. ,, ,, 1911	...	42—45	...
346,198	,,	June 30	4	4%	River Plate 4 p.c. Deb.	85—87	42—45	43½
150,000	10	Sept. 29	6	6/-	San Paulo { 6 p.c. Pref.	10½—11	6—6½	...
125,000	50	June 30	5	5%	{ 5 p.c. Deb.	47—49	35—38	...
135,000	Stk.	Aug. 26	10	5%	Sheffield A	225—234	61—62	...
209,984	,,	,,	10	5%	Do. B	222—224	60—62	...
525,500	,,	,,	10	4½%	Do. C	220—222	59—61	...
133,201	Stk.	Sept. 15	4	4%	Shrewsbury 5 p.c. . .	...	...	...
90,000	10	June 30	9	8%	South African . . .	10½—11½	7—9	...
6,609,895	Stk.	July 28	5/4/0	5%	South Met. Ord. . . .	111—113	68—70	68—68½
250,000	,,	July 14	—	5%	Do. Red. Pref. .	...	93—95	...
1,895,445	,,	,,	3	3%	Do. 3 p.c. Deb. .	72½—74½	48—50	49½—50
224,820	,,	Feb. 25	8½	7½%	South Shields Con. Stk.	157—159	85—87	...
1,087,795	,,	Aug. 11	6	3½%	S'th Suburb'n Ord. 5 p.c.	114—116	68—70	68½—69½
368,837	,,	June 30	5	5%	Do. 5 p.c. Deb. Stk.	116—118	73—76	...
647,740	,,	May 12	7½	3½%	Southampton Ord. . .	99—102	55—58	...
121,275	,,	June 30	4	4%	Do. 4 p.c. Deb. Stk.	...	59—61	...
120,000	,,	Aug. 11	—	6%	Tottenham District { A 5 p.c. .	135—138	63—65	...
782,375	,,	,,	6	4½%	{ B 3½ p.c. .	115—117	53—55	...
181,255	,,	June 15	4	4%	{ 4 p.c. Deb.	87—89	54—57	...
182,380	10	Dec. 30	5	—	Tuscan, Ltd. . . .	5—6	1—2	...
149,900	10	July 1	5	5%	Do. 5 p.c. Deb. Red.	93—95	45—50	...
236,476	Stk.	Aug. 26	5	3½%	Tynemouth 5 p.c. max.	108½—109	66½—68½	...
30,000	,,	Aug. 11	8½	66/3	Wandsworth, Wimbledon, and Epsom—			
255,636	,,	,,	6½	51/3	Wandsworth A 5 p.c.	151—156	78—80	...
108,075	,,	,,	—	46/4½	Do. B 3½ p.c.	129—134	59—61	...
140,865	,,	,,	—	46/4½	Do. C . . .	...	55—57	...
152,000	,,	,,	6½	45/-	New Ordinary . . .	...	57—59	...
98,000	,,	,,	6½	50/-	Wimbledon 5 p.c. . .	117—122	53—55	...
88,416	,,	June 30	5	3½%	Epsom 5 p.c. . . .	121—126	56—58	56½
					3 p.c. Deb. Stk. . .	66—69	44—47	...

* Ex Div.